CLS200 Series
User's Guide

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Please Note: External safety devices must be used with this equipment.

Table of Contents

List of Figures xi

List of Tables xv

1 System Overview 1

Manual Contents 1
Getting Started 2
- Safety Symbols 2
- Initial Inspection 2

Product Features 3
CLS200 Parts List 5
Technical Description 7
- CLS200 7
- TB50 8
- CLS200 Cabling 9

Safety 9
- External Safety Devices 9
- Power-Fail Protection 10

2 Installation 11

Typical Installation 12
Mounting Controller Components 12
- Recommended Tools 13
- Mounting the Controller 13
- Mounting the TB50 16
- Mounting the Power Supply 18
- Mounting the Dual DAC or Serial DAC Module 19

System Wiring 21
- Wiring Recommendations 21
- Noise Suppression 22
- Ground Loops 24

Power Connections 25
- Wiring the Power Supply 25
- Connecting TB50 to CLS200 27

Testing Your System 28
- TB50 or TB18 Test 28
- Digital Output Test 28
- Digital Input Test 29

Sensor Wiring 29
Input Wiring Recommendations 30
Thermocouple Connections 31
RTD Input Connections 32
Reference Voltage Terminals 32
Voltage Input Connections 32
Current Input Connections 33
Pulse Input Connections 34
Wiring Control and Digital I/O 35
Output Wiring Recommendations 35
Cable Tie Wraps 35
Digital Outputs 35
Digital Inputs 38
TB18 Connections (CLS204 and CLS208 Only) 40
TB50 Connections 41
Analog Outputs 43
Wiring the Dual DAC 43
Wiring the Serial DAC 44
Serial Communications 45
EIA/TIA-232 Interface 45
EIA/TIA-485 Interface 47
EIA/TIA-485 Converters and Laptop Computers 49

3 Using the CLS200 51

Front Panel 52
Front Panel Keys 53
Displays 55
Bar Graph Display 55
Single Loop Display 57
Alarm Displays 58
System Alarms 60
Job Display 60
Changing the Setpoint 61
Selecting the Control Status 61
Manual and Automatic Control 61
Autotuning a Loop 62
Using Alarms 64
Alarm Delay 64
Failed Sensor Alarms 65
Process Alarms 66
Global Alarm 68
Ramp/Soak 69

4 Setup 71

How to Access the Setup Menus 71
How to Change a Parameter 72
Setup Global Parameters Menu 74
Load Setup From Job 75
Save Setup to Job 75
Job Select Digital Inputs 76

Job Select Digital Inputs Active 77
Output Override Digital Input 77
Override Digital Input Active 77
Startup Alarm Delay 78
Keyboard Lock Status 78
Power Up Output Status 78
Process Power Digital Input 79
Controller Address 79
Communications Baud Rate 80
Communications Protocol 80
Communications Error Checking 80
AC Line Frequency 81
Digital Output Polarity on Alarm 81
EPROM Information 81
Setup Loop Input Menu 82
Input Type 83
Loop Name 84
Input Units 84
Input Reading Offset 84
Reversed T/C Detection 85
Input Pulse Sample Time 85
Linear Scaling Parameters 86
Input Filter 89
Setup Loop Control Parameters Menu 90
Heat or Cool Control PB 91
Heat or Cool Control TI 91
Heat or Cool Control TD 91
Heat or Cool Output Filter 91
Spread 92
Restore PID Digital Input 92
Setup Loop Outputs Menu 93
Enable or Disable Heat or Cool Outputs 94
Heat or Cool Output Type 94
Heat or Cool Cycle Time 95
SDAC Mode 95
SDAC Low Value 95
SDAC High Value 95
Heat or Cool Output Action 96
Heat or Cool Output Limit 96
Heat or Cool Output Limit Time 96
Sensor Fail Heat or Cool Output 97
Heat or Cool Thermocouple Break Output Average 97
Heat or Cool Linearity 98
Setup Loop Alarms Menu 99
High Process Alarm Setpoint 100
High Process Alarm Type 100
High Process Alarm Output Number 100
Deviation Alarm Value 100
High Deviation Alarm Type 101
High Deviation Alarm Output Number 101
Low Deviation Alarm Type 101
Low Deviation Alarm Output Number 101
Low Process Alarm Setpoint 102

Low Process Alarm Type 102
Low Process Alarm Output Number 102
Alarm Deadband 102
Alarm Delay 103
Manual I/O Test 103
Digital Inputs 103
Test Digital Output 104
Digital Output Number 104
Keypad Test 105
Display Test 105

5 Extruder Control 107
Setup Loop Outputs Menu 107
Cool Output Nonlinear Output Curve 107
Defaults 108
Extruder Control Algorithm 110

6 Enhanced Features 111
Process Variable Retransmit 113
Setup Loop Process Variable Retransmit Menu 113
Process Variable Retransmit Example: Data Logging 115
Cascade Control 118
Setup Loop Cascade Menu 119
Cascade Control Example: Water Tank 121
Ratio Control 124
Setup Loop Ratio Control Menu 125
Ratio Control Example: Diluting KOH 126
Remote Analog Setpoint 129
Remote Analog Setpoint Example: Setting a Setpoint with a PLC 129
Differential Control 131
Differential Control Example: Thermoforming 131

7 Ramp/Soak 133
Features 134
Ramp/Soak Menus 136
Setup Global Parameters Menu 137
Ramp/Soak Time Base 137
Setup Ramp/Soak Profile Menu 137
Edit Ramp/Soak Profile 137
Copy Setup From Profile 138
Tolerance Alarm Time 138
Ready Segment Setpoint 138
Ready Segment Edit Events 139
External Reset Input Number 139
Edit Segment Number 140
Segment Time 140
Segment Setpoint 140
Edit Segment Events 141
Edit Segment Triggers 142
Segment Tolerance 143

Last Segment 144
Repeat Cycles 144
Setpoints and Tolerances for Various Input Types 144
Using Ramp/Soak 145
Ramp/Soak Displays 146
Assigning a Profile to a Loop 148
Running a Profile 148
Holding a Profile or Continuing from Hold 150
Responding to a Tolerance Alarm 151
Resetting a Profile 151
In Case of a Power Failure 152

8 Tuning and Control 153
Control Algorithms 153
On/Off Control 154
Proportional Control 154
Proportional and Integral Control 155
Proportional, Integral and Derivative Control 155
Heat and Cool Outputs 156
Control Outputs 157
Output Control Signals 157
Output Filter 158
Reverse and Direct Action 159
Setting Up and Tuning PID Loops 159
Proportional Band (PB) Settings 159
Integral Settings 160
Derivative Settings 160
General PID Constants by Application 161
Proportional Band Only (P) 161
Proportional with Integral (PI) 161
PI with Derivative (PID) 161

9 Troubleshooting and Reconfiguring 163
When There is a Problem 163
Returning Your Unit 164
Troubleshooting Controllers 164
Process and Deviation Alarms 164
Failed Sensor Alarms 166
System Alarms 166
Other Behaviors 167
Corrective and Diagnostic Procedures 168
Low Power 168
Battery Dead 168
Ambient Warning 168
H/W Ambient Failure 169
H/W Gain or Offset Failure 170
Keys Do Not Respond 170
Checking Analog Inputs 171
Earth Grounding 172
Checking Control Outputs 172
Testing Control Output Devices 173

Testing the TB18 and TB50 173
Testing Control and Digital Outputs 173
Testing Digital Inputs 173
Additional Troubleshooting for Computer Supervised Systems 174
Computer Problems 174
Communications 175
Ground Loops 175
Software Problems 176
NO-Key Reset 176
Replacing the EPROM 176
Changing Communications 179
Installing Scaling Resistors 180
CLS204 and CLS208 Input Circuit 180
CLS204 and CLS208 Current Inputs 181
CLS204 and CLS208 Voltage Inputs 182
CLS204 and CLS208 RTDs and Thermistors 183
CLS216 Input Circuit 184
CLS216 Current Inputs 184
CLS216 Voltage Inputs 185
Scaling and Calibration 186
Configuring Dual DAC Outputs 186
Configuring Serial DAC Outputs 188

10 Linear Scaling Examples 189

Example 1: A 4-to-20 mA Sensor 189
Example 2: A 0-to-5V⎓ (dc) Sensor 191
Example 3: A Pulse Encoder 192

11 Specifications 193

CLS200 System Specifications 193
CLS200 Processor Physical Specifications 194
TB50 Physical Specifications 196
Inputs 200
Outputs 202
CLS200 Power Supply 205
Dual DAC Specifications 207
Dual DAC Inputs 208
Dual DAC Analog Outputs 208
Serial DAC Specifications 209
Serial DAC Inputs 210
Serial DAC Analog Outputs 211

Glossary 213

Index 221

Menu Structure 233

Declaration of Conformity 234

List of Figures

1 System Overview

Figure 1.1—CLS200 Part Numbering 5
Figure 1.2—CLS200 Special Inputs Parts List 6
Figure 1.3—CLS200 Rear Views 7
Figure 1.4—CLS200 Front Panel 8
Figure 1.5—TB50 8

2 Installation

Figure 2.1—CLS200 System Components 12
Figure 2.2—Clearance with Straight SCSI Cable 14
Figure 2.3—Clearance with Right-Angle SCSI Cable 14
Figure 2.4—Wiring Clearances 15
Figure 2.5—Mounting Bracket 16
Figure 2.6—Mounting the TB50 16
Figure 2.7—TB50 Mounted on a DIN Rail (Front) 17
Figure 2.8—TB50 Mounted on DIN Rail (Side) 17
Figure 2.9—Mounting a TB50 with Standoffs 18
Figure 2.10—CLS200 Power Supply Mounting Bracket 19
Figure 2.11—Dual DAC and Serial DAC Dimensions 20
Figure 2.12—CLS200 Series Controller with TB18 25
Figure 2.13—CLS200 Series Controller with TB50 25
Figure 2.14—Power Connections with the CLS200 Power Supply 27
Figure 2.15—CLS200 Connector Locations 30
Figure 2.16—Thermocouple Connections 31
Figure 2.17—RTD Connections to CLS204 or CLS208 32
Figure 2.18—Linear Voltage Signal Connections 33
Figure 2.19—Linear Current Signal Connections 33
Figure 2.20—Encoder with 5V⎓ (dc) TTL Signal 34
Figure 2.21—Encoder Input with Voltage Divider 34
Figure 2.22—Digital Output Wiring 36
Figure 2.23—Sample Heat, Cool and Alarm Output Connections 37
Figure 2.24—Output Connections Using External Power Supply 38
Figure 2.25—TB50 Watchdog Timer Output 38
Figure 2.26—TB18 Watchdog Timer Output 38
Figure 2.27—Wiring Digital Inputs 39
Figure 2.28—Dual DAC with Current Output 43
Figure 2.29—Dual DAC with Voltage Output 44

Figure 2.30—Single/Multiple Serial DACs 45
Figure 2.31—Connecting One CLS200 to a Computer Using EIA/TIA-232 46
Figure 2.32—EIA/TIA-485 Wiring 47
Figure 2.33—Recommended System Connections 48

3 Using the CLS200

Figure 3.1—Operator Displays 51
Figure 3.2—CLS200 Front Panel 52
Figure 3.3—Bar Graph Display 55
Figure 3.4—Single Loop Display 57
Figure 3.5—Single Loop Display, Heat and Cool Outputs Enabled 57
Figure 3.6—Single Loop Display with a Process Alarm 58
Figure 3.7—Failed Sensor Alarm in the Single Loop Display 58
Figure 3.8—Alarm Symbols in the Bar Graph Display 58
Figure 3.9—Activation and Deactivation of Process Alarms 68

4 Setup

Figure 4.1—CLS200 Menu Tree 73
Figure 4.2—Two Points Determine Process Variable Conversion 86
Figure 4.3—Process Variable Limited by Input Reading Range 87
Figure 4.4—Linear and Nonlinear Outputs 98
Figure 4.5—Digital Inputs Screen 104

5 Extruder Control

Figure 5.1—Cool Output Nonlinear Output Curve 108

6 Enhanced Features

Figure 6.1—Enhanced Features Option Menus 112
Figure 6.2—Linear Scaling of Process Variable for Retransmit 115
Figure 6.3—Application Using Process Variable Retransmit 116
Figure 6.4—Relationship Between the Primary Loop's Output and the Secondary Loop's Setpoint 119
Figure 6.5—Application Using Cascade Control 121
Figure 6.6—Secondary Loop Setpoint Related to Primary Loop Output 123
Figure 6.7—Relationship Between the Master Loop's Process Variable and the Ratio Loop's Setpoint 124
Figure 6.8—Application Using Ratio Control 127

7 Ramp/Soak

Figure 7.1—Sample Ramp/Soak Profile 133
Figure 7.2—Setup Ramp/Soak Profiles Menu 136
Figure 7.3—Positive and Negative Tolerances 143
Figure 7.4—Ramp/Soak Screens 145

8 Tuning and Control

Figure 8.1—On/Off Control 154
Figure 8.2—Proportional Control 155
Figure 8.3—Proportional and Integral Control 155
Figure 8.4—Proportional, Integral and Derivative Control 156
Figure 8.5—Time Proportioning and Distributed Zero Crossing Waveforms 157

9 Troubleshooting and Reconfiguring

Figure 9.1—Removal of Electronics Assembly from Case 177
Figure 9.2—Screws Locations on PC Board 178
Figure 9.3—EPROM Location 178
Figure 9.4—Remove EPROM 178
Figure 9.5—Jumper Configurations 179
Figure 9.6—CLS204 and CLS208 Input Circuit 181
Figure 9.7—CLS216 Input Circuit 184
Figure 9.8—Dual DAC 187
Figure 9.9—Serial DAC Voltage/Current Jumper Positions 188

11 Specifications

Figure 11.1—CLS200 Processor Module Dimensions 194
Figure 11.2—CLS200 Clearances with Straight SCSI Cable 195
Figure 11.3—CLS200 Clearances with Right-Angle SCSI Cable 195
Figure 11.4—TB50 Dimensions 197
Figure 11.5—TB50 Dimensions with Straight SCSI Cable 198
Figure 11.6—TB50 Dimensions with Right-Angle SCSI Cable 199
Figure 11.7—Power Supply Dimensions (Bottom View) 206
Figure 11.8—Dual DAC Dimensions 207
Figure 11.9—Serial DAC Dimensions 209

List of Tables

2 Installation

Table 2.1—Cable Recommendations 22
Table 2.2—Power Connections 26
Table 2.3—Digital Output States and Values Stored in the Controller 36
Table 2.4—Digital Inputs States and Values Stored in the Controller 39
Table 2.5—TB18 Connections 40
Table 2.6—TB50 Connections for CLS204 and CLS208 41
Table 2.7—TB50 Connections for CLS216 42
Table 2.8—EIA/TIA-232 Connections 46
Table 2.9—RTS/CTS Pins in DB-9 and DB-25 Connectors 46

3 Using the CLS200

Table 3.1—Bar Graph Display Symbols 55
Table 3.2—Control Status Symbols on the Bar Graph and Single Loop Displays 56
Table 3.3—Alarm Type and Symbols 59

4 Setup

Table 4.1—Global Parameters 74
Table 4.2—Job Select Inputs 76
Table 4.3—Job Selected for Various Input States 76
Table 4.4—Firmware Option Codes 81
Table 4.5—Setup Loop Input 82
Table 4.6—CLS200 Input Types and Ranges 83
Table 4.7—Input Character Sets 84
Table 4.8—Input Reading Offset 85
Table 4.9—Display Formats 87
Table 4.10—Setup Loop Control Parameters 90
Table 4.11—Setup Loop Outputs 93
Table 4.12—Heat / Cool Output Types 94
Table 4.13—Setup Loop Alarms 99
Table 4.14—Manual I/O Test 103

5 Extruder Control

Table 5.1—Default Control Parameters for Fan Cool Output 109
Table 5.2—Default Control Parameters for Oil Cool Output 109
Table 5.3—Default Control Parameters for H2O Cool Output 109

6 Enhanced Features

Table 6.1—Application Example: Setting Up Process Variable Retransmit 117
Table 6.2—Application Example: Setting Up Cascade Control 122
Table 6.3—Application Example: Setting Up Ratio Control 128
Table 6.4—Application Example: Setting Up Remote Setpoint 130
Table 6.5—Application Example: Setting Up Differential Control 132

7 Ramp/Soak

Table 7.1—Ramp/Soak Specifications 135
Table 7.2—Trigger Latch Logic 143
Table 7.3—Display Formats 145
Table 7.4—Ramp/Soak Single Loop Display 146
Table 7.5—Ramp/Soak Control Status Symbols 147
Table 7.6—Ramp/Soak Profile Modes 150

8 Tuning and Control

Table 8.1—Proportional Band Settings 159
Table 8.2—Integral Term and Reset Settings 160
Table 8.3—Derivative Term Versus Rate 160
Table 8.4—General PID Constants 162

9 Troubleshooting and Reconfiguring

Table 9.1—Controller Alarm Codes for Process and Deviation Alarms 164
Table 9.2—Operator Response to Alarms 165
Table 9.3—Failed Sensor Alarm Codes 166
Table 9.4—Hardware Error Messages 166
Table 9.5—Other Symptoms 167
Table 9.6—Resistor Values for CLS204 and CLS208 Current Inputs 181
Table 9.7—Resistor Locations for CLS204 and CLS208 Current Inputs 181
Table 9.8—Resistor Values for CLS204 and CLS208 Voltage Inputs 182
Table 9.9—Resistor Locations for CLS204 and CLS208 Voltage Inputs 182
Table 9.10—Resistor Values for CLS204/208 RTD and Thermistor Inputs 183
Table 9.11—Resistor Locations for CLS204/208 RTD and Thermistor Inputs 183
Table 9.12—Resistor Values for CLS216 Current Inputs 184
Table 9.13—Resistor Locations for CLS216 Current Inputs 185
Table 9.14—Resistor Values for CLS216 Voltage Inputs 185
Table 9.15—Resistor Locations for CLS216 Voltage Inputs 186
Table 9.16—Dual DAC Jumper Settings 187

10 Linear Scaling Examples

Table 10.1—Input Readings 190
Table 10.2—Scaling Values 190
Table 10.3—Input Readings and Calculations 191
Table 10.4—Scaling Values 191
Table 10.5—Scaling Values 192

11 Specifications

Table 11.1—Agency Approvals / Compliance 193
Table 11.2—Environmental Specifications 194
Table 11.3—Physical Dimensions 194
Table 11.4—Processor with Straight SCSI 195
Table 11.5—Processor with Right Angle SCSI 195
Table 11.6—Processor Connections 196
Table 11.7—TB50 Physical Dimensions 196
Table 11.8—TB50 Connections 197
Table 11.9—TB50 with Straight SCSI 198
Table 11.10—TB50 with Right Angle SCSI 199
Table 11.11—Analog Inputs 200
Table 11.12—Pulse Inputs 201
Table 11.13—Thermocouple Range and Resolution 201
Table 11.14—RTD Range and Resolution 201
Table 11.15—Input Resistance for Voltage Inputs 202
Table 11.16—Digital Inputs 202
Table 11.17—Digital Outputs Control / Alarm 203
Table 11.18—CPU Watchdog Output 203
Table 11.19—5V⎓ (dc) Output (Power to Operate Solid-State Relays) 204
Table 11.20—Reference Voltage Output (Power to Operate Bridge Circuit Sensors) 204
Table 11.21—Processor Serial Interface 204
Table 11.22—Processor Power Requirements 204
Table 11.23—Power Supply Environmental Specifications 205
Table 11.24—Power Supply Agency Approvals / Compliance 205
Table 11.25—Power Supply Physical Specifications 205
Table 11.26—Power Supply with Mounting Bracket 205
Table 11.27—Power Supply Inputs 206
Table 11.28—Power Supply Outputs 206
Table 11.29—Dual DAC Environmental Specifications 207
Table 11.30—Dual DAC Physical Specifications 207
Table 11.31—Dual DAC Power Requirements 208
Table 11.32—Dual DAC Specifications by Output Range 208
Table 11.33—Serial DAC Environmental Specifications 209
Table 11.34—Serial DAC Physical Specifications 209
Table 11.35—Serial DAC Agency Approvals / Compliance 210
Table 11.36—Serial DAC Inputs 210
Table 11.37—Serial DAC Power Requirements 210
Table 11.38—Serial DAC Analog Output Specifications 211

1

System Overview

Manual Contents

This manual describes how to install, set up, and operate a CLS204, CLS208 or CLS216 controller. Each chapter covers a different aspect of your control system and may apply to different users:

- **Chapter 1: System Overview** provides a component list and summary of features for the CLS200 series controllers.
- **Chapter 2: Installation** provides detailed instructions on installing the CLS200 series controller and its peripherals.
- **Chapter 3: Using the CLS200** provides an overview of operator displays used for system monitoring and job selection.
- **Chapter 4: Setup** provides detailed descriptions of all menus and parameters for controller setup.
- **Chapter 5: Extruder Control** explains the additional features of a CLS200 controller equipped with Extruder Control Firmware.
- **Chapter 6: Enhanced Features** describes process variable retransmit, ratio, differential and cascade control features available with the enhanced features option.
- **Chapter 7: Ramp/Soak** explains how to set up and use the features of the ramp/soak option.
- **Chapter 8: Tuning and Control** describes available control algorithms and provides suggestions for applications.
- **Chapter 9: Troubleshooting and Reconfiguring** includes troubleshooting, upgrading and reconfiguring procedures for technical personnel.

- **Chapter 10: Linear Scaling Examples** provides an example configuring a pressure sensor, a flow sensor, and an encoder using linear scaling.
- **Chapter 11: Specifications** lists detailed specifications of the controller and optional components.

Getting Started

The following sections provide information regarding product features, technical descriptions, safety requirements, and preparation for operation.

Safety Symbols

These symbols are used throughout this manual:

WARNING! ***Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.***

CAUTION! ***Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury or property damage.***

NOTE! ***Indicates pertinent information or an item that may be useful to document or label for later reference.***

Initial Inspection

Accessories may or may not be shipped in the same container as the CLS200, depending upon their size. Check the shipping invoice carefully against the contents received in all boxes.

Product Features

The CLS200 series controllers provide 4, 8 or 16 fully independent control loops. When used as a stand-alone controller, you may operate the CLS200 via the two-line 16-character display and touch keypad. You can also use it as the key element in a computer-supervised data acquisition and control system; the CLS200 can be locally or remotely controlled via an EIA/TIA-232 or EIA/TIA-485 serial communications interface.

The CLS200 features include:

- **Direct Connection of Mixed Thermocouple Sensors:** Connect most thermocouples to the controller with no hardware modifications. Thermocouple inputs feature reference junction compensation, linearization, process variable offset calibration to correct for sensor inaccuracies, detection of broken, shorted or reversed thermocouples, and a choice of Fahrenheit or Celsius display.
- **Accepts Resistive Temperature Detectors (RTDs):** Use 3-wire, 100 Ω, platinum, 0.00385-curve sensors with two choices for range and precision of measurements. (To use this input, order a CLS204 or CLS208 controller with scaling resistors.)
- **Automatic Scaling for Linear Analog Inputs:** The CLS200 series automatically scales linear inputs used with industrial process sensors. Enter two points, and all input values are automatically scaled in your units. Scaling resistors must be installed.
- **Dual Outputs:** The CLS200 series includes both heat and cool control outputs for each loop. Independent control parameters are provided for each output.
- **Independently Selectable Control and Output Modes:** You can set each control output to on/off, time proportioning, Serial DAC (digital-to-analog converter), or distributed zero crossing mode. Set up to two outputs per loop for on/off, P, PI or PID control with reverse or direct action.
- **Control Outputs:** Set high/low deviation and high/low process limits to operate digital outputs as on/off control functions or alarms.
- **Flexible Alarm Outputs:** Independently set high/low process alarms and a high/low deviation band alarm for each loop. Alarms can activate a digital output by themselves, or they can be grouped with other alarms to activate an output.
- **Global Alarm Output:** When any alarm is triggered, the global alarm output is also triggered, and it stays on until you acknowledge it.

- **CPU Watchdog:** The CLS200 series CPU watchdog timer output notifies you of system failure. Use it to hold a relay closed while the controller is running, so you are notified if the microprocessor shuts down.
- **Front Panel or Computer Operation:** Set up and run the controller from the front panel or from a local or remote computer. Watlow Anafaze offers WatView, a Windows® compatible Human Machine Interface (HMI) software package that includes data logging and graphing features in addition to process monitoring and parameter setup screens.
- **Modbus RTU Protocol, EIA/TIA-232 and 485 Communications:** Connect to PLCs, operator interface terminals and third-party software packages using the widely supported Modbus RTU protocol.
- **Multiple Job Storage:** Store up to eight jobs in memory, and access them locally by entering a single job number or remotely via digital inputs. Each job is a set of operating conditions, including setpoints and alarms.
- **Nonlinear Output Curves:** Select either of two nonlinear output curves for each control output.
- **Autotuning:** Use the autotune feature to set up your system quickly and easily. The CLS200 internal expert system table finds the correct PID parameters for your process.
- **Pulse Counter Input:** Use the pulse counter input for precise control of motor or belt speed.
- **Low Power Shutdown:** The controller shuts down and turns off all outputs when it detects the input voltage drop below the minimum safe operating level.

CLS200 Parts List

You may have received one or more of the following components. See *Figure 2.1 on page 12* for CLS200 configuration information.

- CLS200 series controller
- Controller mounting kit
- TB50 with 50-pin SCSI cable
- EIA/TIA-232 or EIA/TIA-485 communications cable
- Power supply with mounting bracket and screws
- Serial DAC (digital-to-analog converter)
- Special input resistors (installed in CLS200)
- User's guide

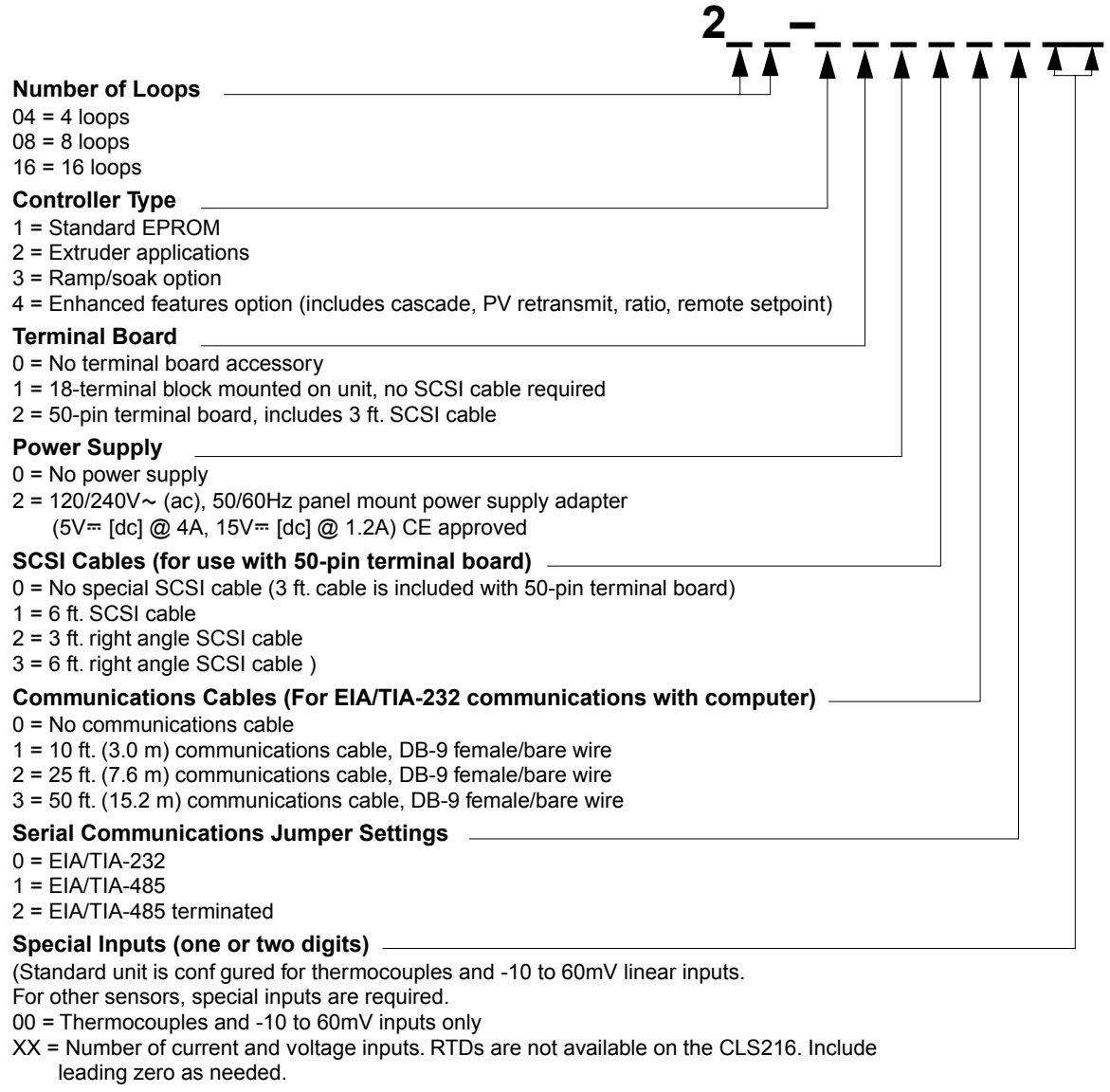

2 –
Number of Loops
04 = 4 loops
08 = 8 loops
16 = 16 loops
Controller Type
1 = Standard EPROM
2 = Extruder applications
3 = Ramp/soak option
4 = Enhanced features option (includes cascade, PV retransmit, ratio, remote setpoint)
Terminal Board
0 = No terminal board accessory
1 = 18-terminal block mounted on unit, no SCSI cable required
2 = 50-pin terminal board, includes 3 ft. SCSI cable
Power Supply
0 = No power supply
2 = 120/240V~ (ac), 50/60Hz panel mount power supply adapter
(5V⎓ [dc] @ 4A, 15V⎓ [dc] @ 1.2A) CE approved
SCSI Cables (for use with 50-pin terminal board)
0 = No special SCSI cable (3 ft. cable is included with 50-pin terminal board)
1 = 6 ft. SCSI cable
2 = 3 ft. right angle SCSI cable
3 = 6 ft. right angle SCSI cable)
Communications Cables (For EIA/TIA-232 communications with computer)
0 = No communications cable
1 = 10 ft. (3.0 m) communications cable, DB-9 female/bare wire
2 = 25 ft. (7.6 m) communications cable, DB-9 female/bare wire
3 = 50 ft. (15.2 m) communications cable, DB-9 female/bare wire
Serial Communications Jumper Settings
0 = EIA/TIA-232
1 = EIA/TIA-485
2 = EIA/TIA-485 terminated
Special Inputs (one or two digits)
(Standard unit is conf gured for thermocouples and -10 to 60mV linear inputs.
For other sensors, special inputs are required.
00 = Thermocouples and -10 to 60mV inputs only
XX = Number of current and voltage inputs. RTDs are not available on the CLS216. Include leading zero as needed.

Figure 1.1 CLS200 Part Numbering

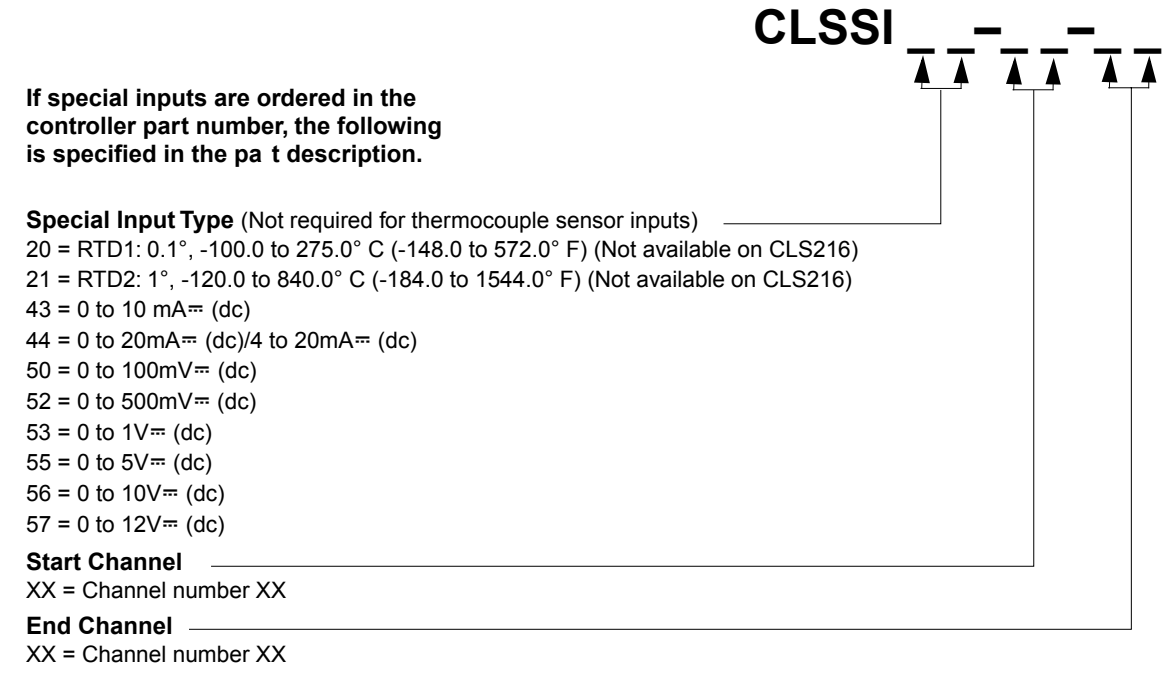

CLSSI _ _ – _ _ – _ _
If special inputs are ordered in the controller part number, the following is specified in the pa t description.
Special Input Type (Not required for thermocouple sensor inputs)
20 = RTD1: 0.1°, -100.0 to 275.0° C (-148.0 to 572.0° F) (Not available on CLS216)
21 = RTD2: 1°, -120.0 to 840.0° C (-184.0 to 1544.0° F) (Not available on CLS216)
43 = 0 to 10 mA⎓ (dc)
44 = 0 to 20mA⎓ (dc)/4 to 20mA⎓ (dc)
50 = 0 to 100mV⎓ (dc)
52 = 0 to 500mV⎓ (dc)
53 = 0 to 1V⎓ (dc)
55 = 0 to 5V⎓ (dc)
56 = 0 to 10V⎓ (dc)
57 = 0 to 12V⎓ (dc)
Start Channel
XX = Channel number XX
End Channel
XX = Channel number XX
Note:
Make sure the number of special inputs specif ed is equal to the number of special inputs in the controller part number.
Uninstalled kits are available.

Figure 1.2 CLS200 Special Inputs Parts List

Technical Description

This section contains a technical description of each component of your CLS200 series controller.

CLS200

The CLS200 is housed in an 1/8-DIN panel mount package. It contains the CPU, RAM with a built-in battery, EPROM, serial communications, digital I/O, analog inputs, the screen and touch keypad.

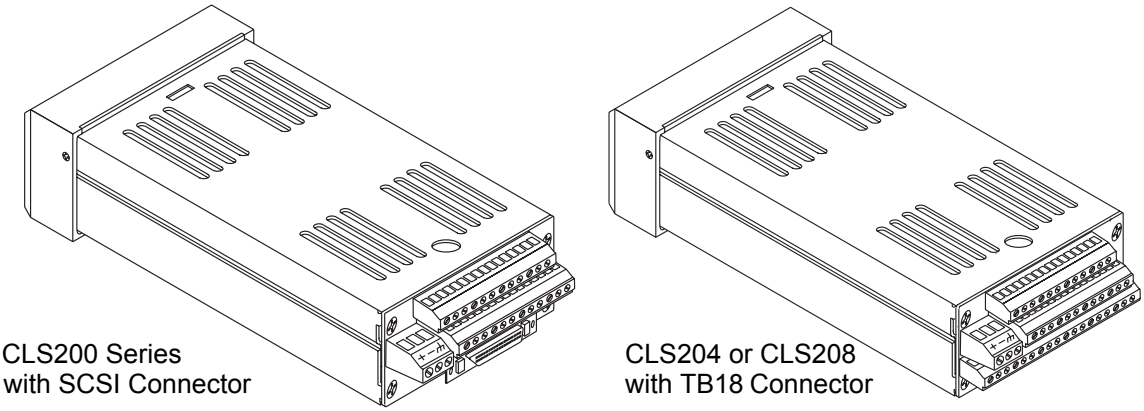


Figure 1.3 CLS200 Rear Views

The CLS200 has the following features:

- Keypad and 2-line 16-character display.
- Screw terminals for the power and analog inputs and communications.
- Input power is 12 to 24V⎓ (dc) at 1 Amp.
- A 50-pin SCSI cable connects the digital inputs and outputs to the 50-terminal block (TB50). The CLS204 and CLS208 are available with an 18-terminal block (TB18) in place of the SCSI connector, as shown in *Figure 1.3*.

The firmware resides in an EPROM. See *Replacing the EPROM on page 176* for information on removing and replacing the EPROM.

The operating parameters are stored in battery-backed RAM. If there is a power loss the operating parameters are unchanged. The battery has a ten-year shelf life, and it is not used when the unit is on.

The microprocessor performs all calculations for input signal linearization, PID control, alarms and communications.

Front Panel Description

The display and touch keypad provide an intelligent way to operate the controller. The display has 16 alphanumeric or graphic characters per line. The 8-key keypad allows you to change the operating parameters, controller functions, and displays.

The information-packed displays show process variables, setpoints, and output levels for each loop. A bar graph display, single loop display, scanning display and an alarm display offer a real-time view of process conditions. Two access levels allow operator changes and supervisor changes.

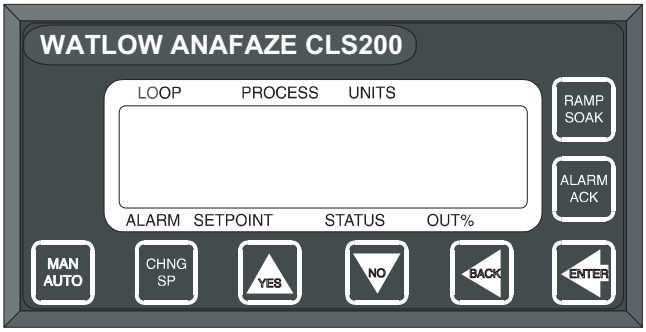


Figure 1.4 CLS200 Front Panel

TB50

The TB50 is a screw-terminal interface for control wiring which allows you to connect relays, encoders and discrete I/O devices to the CLS200. The screw terminal blocks accept wires as large as 18 AWG (0.75 mm^2). A 50-pin SCSI cable connects the TB50 to the CLS200.

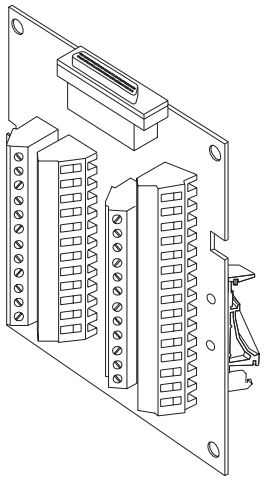


Figure 1.5 TB50

CLS200 Cabling

Watlow Anafaze provides cables required to install your CLS200. A 50-pin SCSI cable connects the TB50 to the CLS200.

The optional cable used to connect the CLS200 to a computer using EIA/TIA-232 communications has a DB9 or DB25 connector for the computer and bare wires for connecting to the CLS200.

Safety

Watlow Anafaze has made every effort to ensure the reliability and safety of this product. In addition, we have provided recommendations that will allow you to safely install and maintain this controller.

External Safety Devices

The CLS200 controller may fail full-on (100% output power) or full-off (0% output power), or may remain full-on if an undetected sensor failure occurs. For more information about failed sensor alarms, see *Failed Sensor Alarms on page 65.*

Design your system to be safe even if the controller sends a 0% or 100% output power signal at any time. Install independent, external safety devices that will shut down the system if a failure occurs.

Typically, a shutdown device consists of an FM-approved high/low process limit controller that operates a shutdown device such as an mechanical contactor. The limit controller monitors for a hazardous condition such as an under-temperature or over-temperature fault. If a hazardous condition is detected, the limit controller sends a signal to open the contactor.

The safety shutdown device (limit controller and contactor) must be independent from the process control equipment.

WARNING! ***The controller may fail in a 0% or 100% power output state. To prevent death, personal injury, equipment damage or property damage, install external safety shutdown devices. If death or injury may occur, you* must *install FM-approved safety shutdown devices that operate independently from the process control equipment.***

With proper approval and installation, thermal fuses may be used in some processes.

Power-Fail Protection

In the occurrence of a sudden loss of power, this controller can be programmed to reset the control outputs to off (this is the default). Typically, when power is re-started, the controller restarts to data stored in memory. If you have programmed the controller to restart with control outputs on, the memory-based restart might create an unsafe process condition for some installations. Therefore, you should only set the restart with outputs on if you are certain your system will safely restart. (See the *Process Power Digital Input on page 79*).

When using a computer or host device, you can program the software to automatically reload desired operating constants or process values on power-up. Keep in mind that these convenience features do not eliminate the need for independent safety devices.

Contact Watlow Anafaze immediately if you have any questions about system safety or system operation.

2

Installation

This chapter describes how to install the CLS200 series controller and its peripherals. Installation of the controller involves the following procedures:

- Determining the best location for the controller
- Mounting the controller and TB50
- Power connection
- Input wiring
- Communications wiring (EIA/TIA-232 or EIA/TIA-485)
- Output wiring

WARNING! ***Risk of electric shock. Shut off power to your entire process before you begin installation of the controller.***

WARNING! ***The controller may fail in a 0% or 100% power output state. To prevent death, personal injury, equipment damage or property damage, install external safety shutdown devices. If failure may cause death or injury, you must install FM-approved safety shutdown devices that operate independently from the process control equipment.***

Typical Installation

Figure 2.1 shows typical installations of the controller with the TB50 and the TB18 terminal blocks. The type of terminal block you use greatly impacts the layout and wiring of your installation site. *(*See *Figures 2.2 to 2.11.)*

We recommend that you read this entire chapter first before beginning the installation procedure. This will help you to carefully plan and assess the installation.

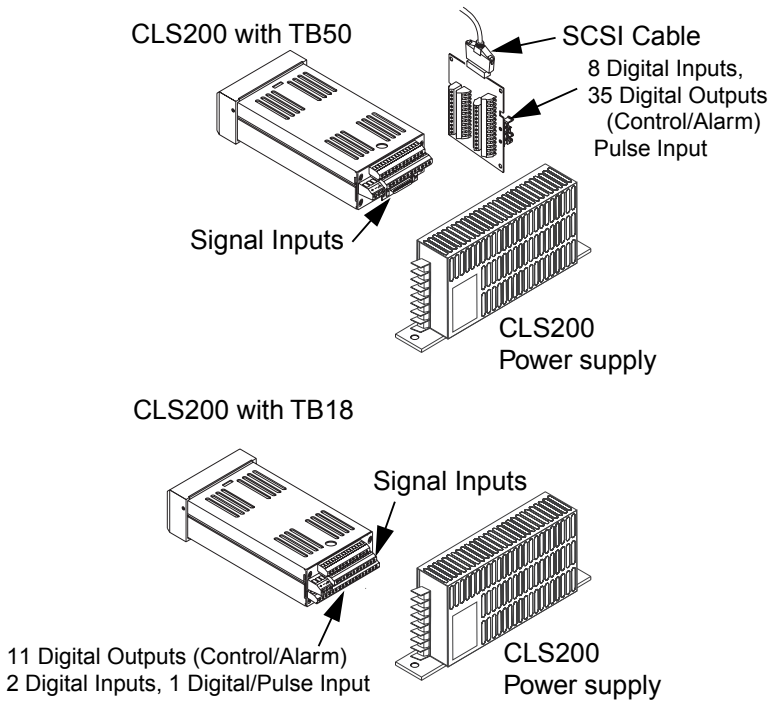


Figure 2.1 CLS200 System Components

Mounting Controller Components

Install the controller in a location free from excessive heat (more than 50º C [122° F]), dust, and unauthorized handling. Electromagnetic and radio frequency interference can induce noise on sensor wiring. Select locations for the CLS200 and TB50 such that wiring can be routed clear of sources of interference such as high voltage wires, power switching devices and motors.

NOTE! For indoor use only.

WARNING! ***To reduce the risk of fire or electric shock, install the CLS200 in a controlled environment, relatively free of contaminants.***

Recommended Tools

Use any of the following tools to cut a hole of the appropriate size in the panel.

- Jigsaw and metal file, for stainless steel and heavyweight panel doors.
- Greenlee 1/8-DIN rectangular punch (Greenlee part number 600-68), for most panel materials and thicknesses.
- Nibbler and metal file, for aluminum and lightweight panel doors.

You will also need these tools:

- Phillips head screwdriver
- 1/8 in. (3 mm) flathead screwdriver for wiring
- Multimeter

Mounting the Controller

Mount the controller before you mount the terminal block or do any wiring. The controller's placement affects placement and wiring considerations for the other components of your system.

Ensure there is enough clearance for mounting brackets, terminal blocks, and cable and wire connections; the controller extends up to 7.0 inches (178 mm) behind the panel face and the screw brackets extend 0.5 inch (13 mm) above and below it. If using a straight SCSI cable, allow for an additional 1.6 inches (41 mm) beyond the terminal block. If using a right-angle SCSI cable, allow an additional 0.6 inch (15 mm). (See *Figure 2.2 and Figure 2.3.)*

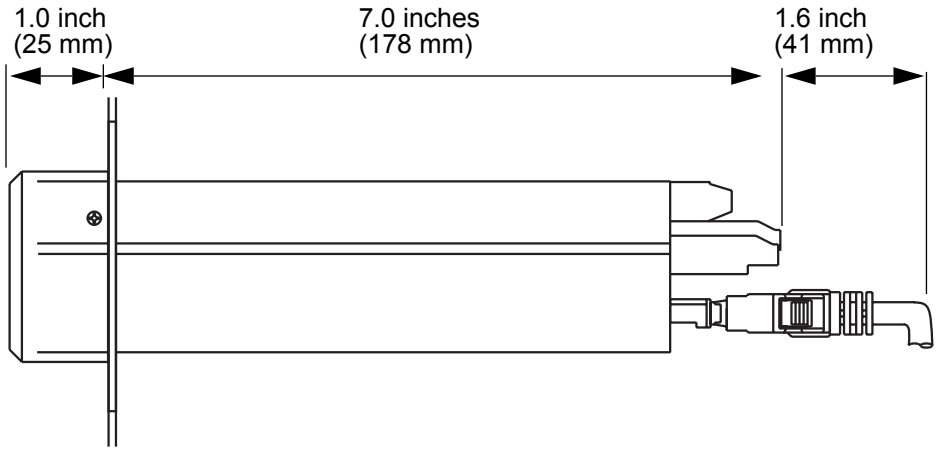


Figure 2.2 Clearance with Straight SCSI Cable

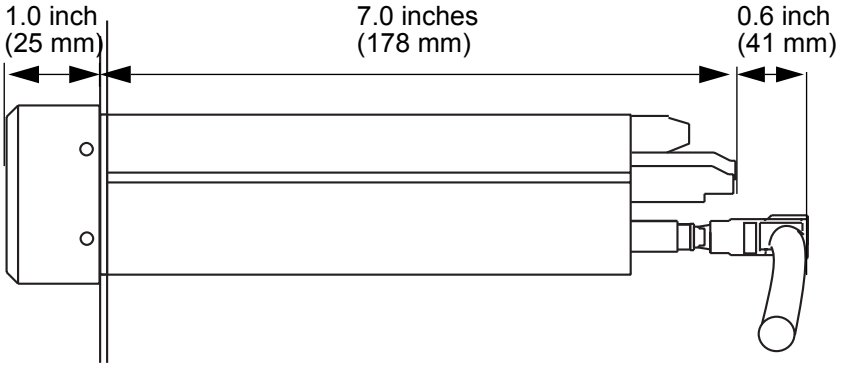


Figure 2.3 Clearance with Right-Angle SCSI Cable

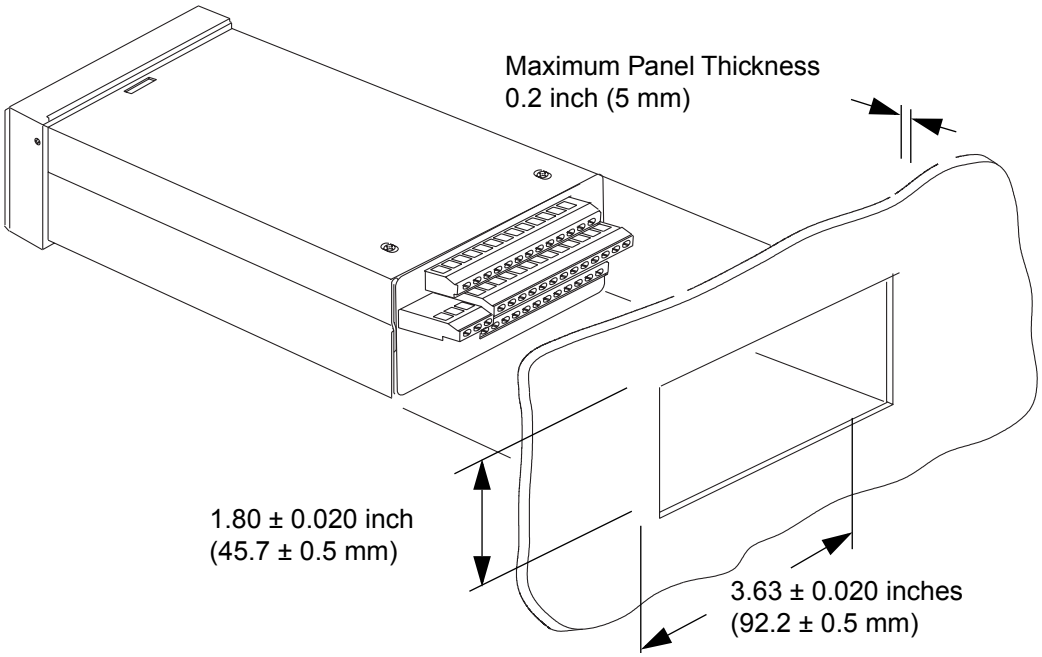


Figure 2.4 Wiring Clearances

We recommend you mount the controller in a panel not more than 0.2 in. (5 mm) thick.

1. Choose a panel location free from excessive heat (more than 50° C [122° F]), dust, and unauthorized handling. (Make sure there is adequate clearance for the mounting hardware, terminal blocks, and cables. The controller extends 7.40 in. (178 mm) behind the panel. Allow for an additional 0.60 to 1.60 in. (15 to 41 mm) beyond the connectors.)
2. Temporarily cover any slots in the metal housing so that dirt, metal filings, and pieces of wire do not enter the housing and lodge in the electronics.
3. Cut a hole in the panel 1.80 in. (46 mm) by 3.63 in. (92 mm) as shown below. (This picture is NOT a template; it is for illustration only.) Use caution; the dimensions given here have 0.02 in. (1 mm) tolerances.
4. Remove the brackets and collar from the processor module, if they are already in place.
5. Slide the processor module into the panel cutout.
6. Slide the mounting collar over the back of the processor module, making sure the mounting screw indentations face toward the back of the processor module.

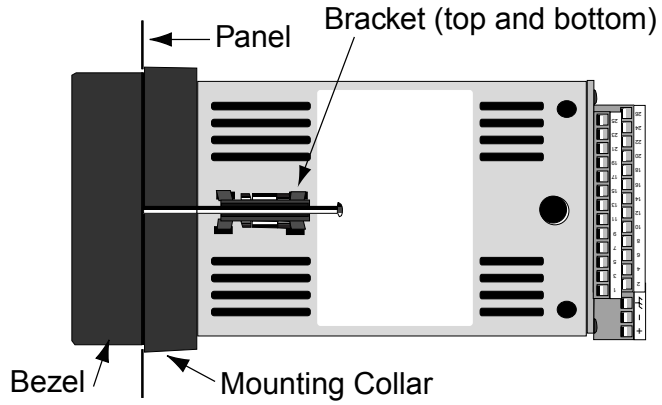


Figure 2.5 Mounting Bracket

7. Loosen the mounting bracket screws enough to allow for the mounting collar and panel thickness. Place each mounting bracket into the mounting slots (head of the screw facing the back of the processor module). Push each bracket backward then to the side to secure it to the processor module case.
8. Make sure the case is seated properly. Tighten the installation screws firmly against the mounting collar to secure the unit. Ensure that the end of the mounting screws fit into the indentations on the mounting collar.

Mounting the TB50

There are two ways you can mount the TB50: Use the preinstalled DIN rail mounting brackets or use the plastic standoffs. Follow the corresponding procedures to mount the board.

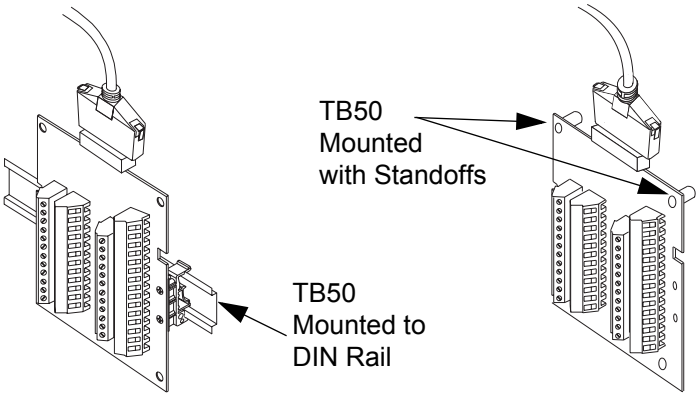


Figure 2.6 Mounting the TB50

DIN Rail Mounting

Snap the TB50 on to the DIN rail by placing the hook side on the rail first, then pushing the snap latch side in place. *(See Figure 2.7.)*

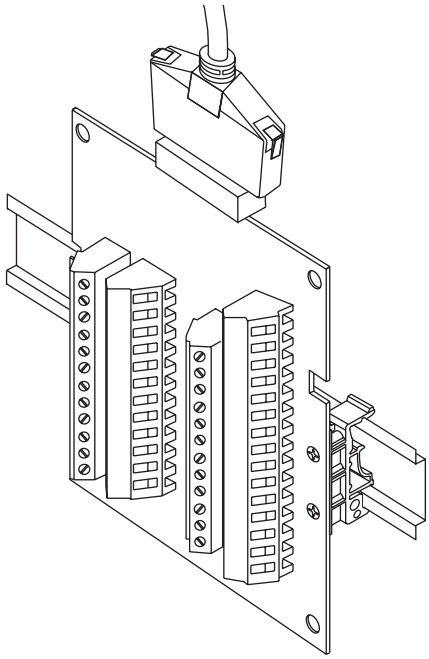


Figure 2.7 TB50 Mounted on a DIN Rail (Front)

To remove the TB50 from the rail, use a flathead screwdriver to unsnap the bracket from the rail. *(See Figure 2.8.)*

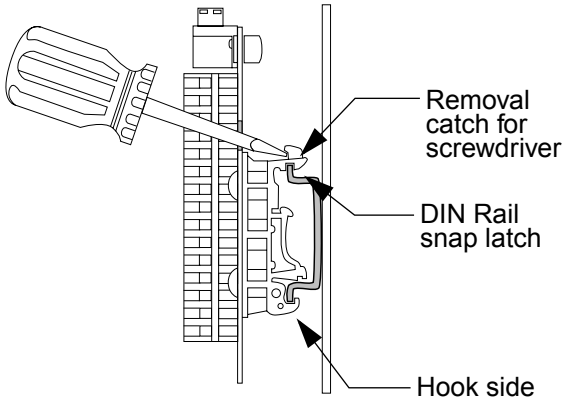


Figure 2.8 TB50 Mounted on DIN Rail (Side)

Mounting with Standoffs

1. Remove the DIN rail mounting brackets from the TB50.
2. Select a location with enough clearance to remove the TB50, its SCSI cable and the controller itself.
3. Mark the four mounting holes.
4. Drill and tap four mounting holes for #6 (3.5 mm) screws or bolts.
5. Mount the TB50 with four screws.

There are four smaller holes on the terminal board. Use these holes to secure wiring to the terminal block with tie wraps.

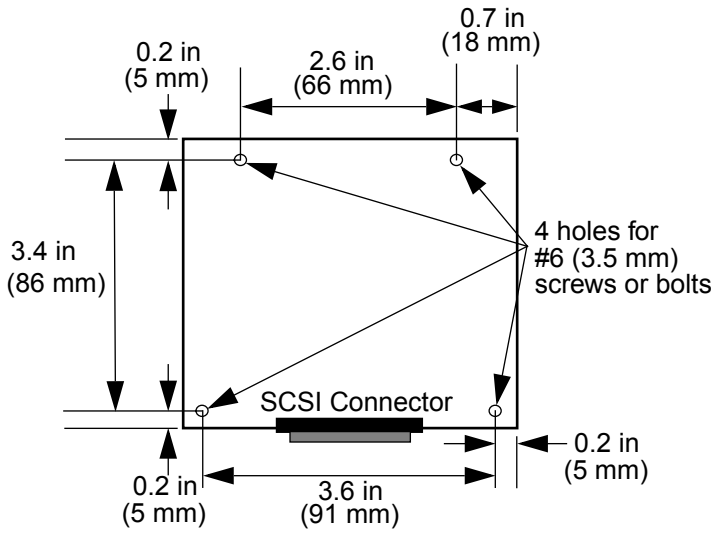


Figure 2.9 Mounting a TB50 with Standoffs

Mounting the Power Supply

If you use your own power supply for the CLS200, refer to the power supply manufacturer's instructions for mounting information. Choose a Class 2 power supply that supplies an isolated regulated 12 to 24V⎓ (dc) at 1 A.

Mounting Environment

Leave enough clearance around the power supply so that it can be removed.

Mounting the Dual DAC or Serial DAC Module

This section describes how to install the optional Dual DAC and Serial DAC digital-to-analog converters.

Installation

Installation of the Dual DAC and Serial DAC is essentially the same. The main differences are in the dimensions and the wiring. Follow this procedure to correctly install these devices.

Jumpers

The output signal range of the Dual DAC and Serial DAC modules is configured with jumpers. See *Configuring Dual DAC Outputs on page 186* and *Configuring Serial DAC Outputs on page 188* for information on setting these jumpers.

Mounting

1. Select a location. The unit is designed for wall mounting. Install it as close to the controller as possible.
2. Mark and drill four holes for screw mounting. Holes accommodate #8 (4.0 mm) size screws. See *Figure 2.11* for screw locations. Install the unit with the four screws.

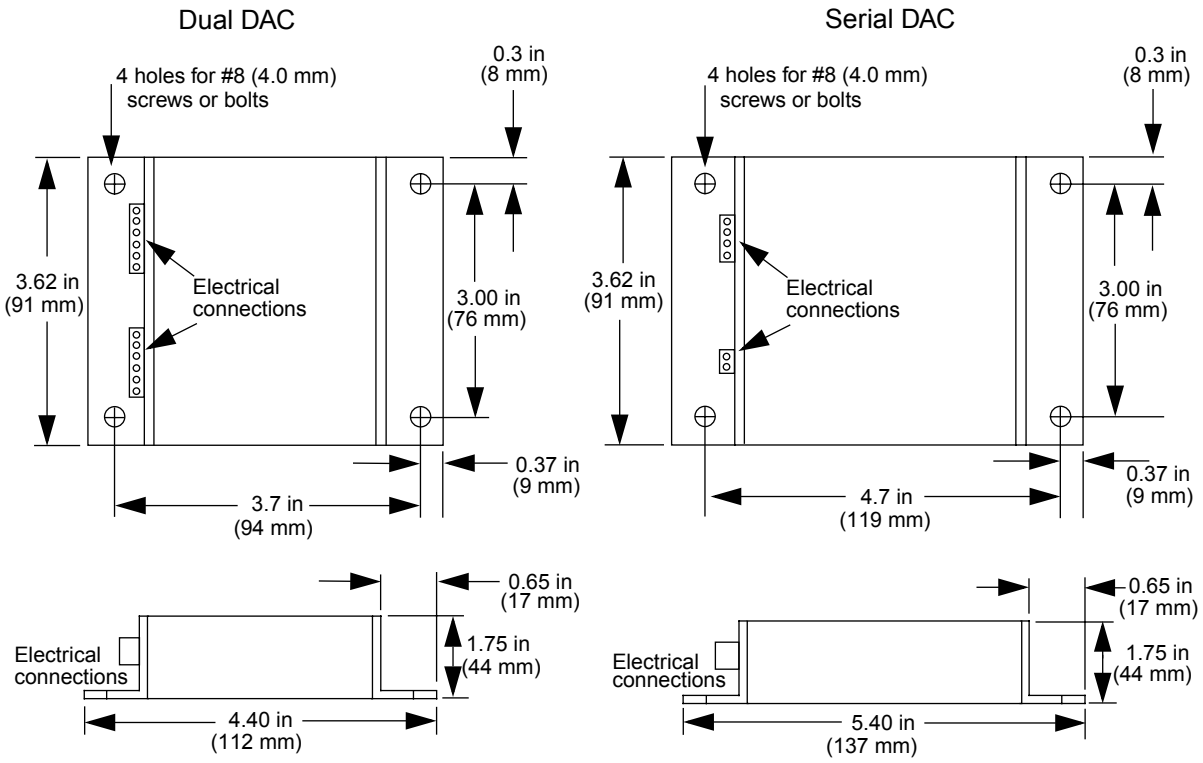


Figure 2.11 Dual DAC and Serial DAC Dimensions

System Wiring

Successful installation and operation of the control system can depend on placement of the components and on selection of the proper cables, sensors, and peripheral components.

Routing and shielding of sensor wires and proper grounding of components can insure a robust control system. This section includes wiring recommendations, instructions for proper grounding and noise suppression, and considerations for avoiding ground loops.

WARNING! ***To reduce the risk of electrical shock, fire, and equipment damage, follow all local and national electrical codes. Correct wire sizes, fuses and thermal breakers are essential for safe operation of this equipment.***

CAUTION! ***Do not wire bundles of low-voltage signal and control circuits next to bundles of high-voltage ac wiring. High voltage may be inductively coupled onto the low-voltage circuits, which may damage the controller or induce noise and cause poor control.***

Physically separate high-voltage circuits from low-voltage circuits and from CLS200 hardware. If possible, install high-voltage ac power circuits in a separate panel.

Wiring Recommendations

Follow these guidelines for selecting wires and cables:

- Use stranded wire. (Solid wire can be used for fixed service; it makes intermittent connections when you move it for maintenance.)
- Use 20 AWG (0.5 mm^2) thermocouple extension wire. Larger or smaller sizes may be difficult to install, may break easily, or may cause intermittent connections.
- Use shielded wire. The electrical shield protects the signals and the CLS200 from electrical noise. Connect one end of the input and output wiring shield to earth ground.
- Use copper wire for all connections other than thermocouple sensor inputs.

Table 2.1 Cable Recommendations

Function	Mfr. P/N	No. of Wires	AWG	mm^2	Maximum Length
Analog Inputs	Belden 9154 Belden 8451	2 2	20 22	0.5 0.5	
RTD Inputs	Belden 8772 Belden 9770	3 3	20 22	0.5 0.5	
Thermocouple Inputs	T/C Ext. Wire	2	20	0.5	
Control Outputs and Digital I/O	Belden 9539 Belden 9542 Ribbon Cable	9 20 50	24 24 22 to 14	0.2 0.2 0.5 to 2.5	
Analog Outputs	Belden 9154 Belden 8451	2 2	20 22	0.5 0.5	
Computer Communication: EIA/TIA-232, 422 or 485, or 20 mA	Belden 9729 Belden 9730 Belden 9842 Belden 9843 Belden 9184	4 6 4 6 4	24 24 24 24 22	0.2 0.2 0.2 0.2 0.5	4,000 ft. (1,219 m) 4,000 ft. (1,219 m) 6,000 ft. (1,829 m)

Noise Suppression

The CLS200's outputs are typically used to drive solid state relays. These relays may in turn operate more inductive types of loads such as electromechanical relays, alarm horns and motor starters. Such devices may generate electromagnetic interference (EMI or noise). If the controller is placed close to sources of EMI, it may not function correctly. Below are some tips on how to recognize and avoid problems with EMI.

For earth ground wire, use a large gauge and keep the length as short as possible. Additional shielding may be achieved by connecting a chassis ground strap from the panel to CLS200 case.

Symptoms of RFI/EMI

If your controller displays the following symptoms, suspect EMI:

- The controller's display blanks out and then reenergizes as if power had been turned off for a moment.
- The process variable does not display correctly.

EMI may also damage the digital output circuit—so digital outputs will not turn on. If the digital output circuit is damaged, return the controller to Watlow Anafaze for repair.

Avoiding RFI/EMI

- To avoid or eliminate most RFI/EMI noise problems:
- Connect the CLS200 case to earth ground. The CLS200 system includes noise suppression circuitry. This circuitry requires proper grounding.
- Separate the 120 or 240V~ (ac) power leads from the low-level input and output leads connected to the CLS200 series controller. Do not run the digital I/O or control output leads in bundles with ac wires.
- Where possible, use solid-state relays (SSRs) instead of electromechanical relays. If you must use electromechanical relays, try to avoid mounting them in the same panel as the CLS200 series equipment.
- If you must use electromechanical relays and you must place them in a panel with CLS200 series equipment, use a 0.01 microfarad capacitor rated at 1000V~ (ac) (or higher) in series with a 47 Ω, 0.5 watt resistor across the N.O. contacts of the relay load. This is known as a snubber network and can reduce the amount of electrical noise.
- You can use other voltage suppression devices, but they are not usually required. For instance, you can place a metal oxide varistor (MOV) rated at 130V~ for 120V~ (ac) control circuits across the load, which limits the peak ac voltage to about 180V~ (ac) (Watlow Anafaze part number 26-130210-00). You can also place a transorb (back-to-back zener diodes) across the digital output, which limits the digital output voltage.

Additional Recommendations for a Noise Immune System

It is strongly recommended that you:

- Isolate outputs through solid-state relays, where possible.
- Isolate RTDs or "bridge" type inputs from ground.
- Isolate digital inputs from ground through solid state relays. If this is not possible, then make sure the digital input is the only connection to earth ground other than the chassis ground.
- If you are using EIA/TIA-232 from a non-isolated host, either (1) do not connect any other power common point to earth ground, or (2) use an optical isolator in the communications line.

Ground Loops

Ground loops occur when current passes from the process through the controller to ground. This can cause instrument errors or malfunctions.

A ground loop may follow one of these paths, among others:

- From one sensor to another.
- From a sensor to the communications port.
- From a sensor to the dc power supply.

The best way to avoid ground loops is to minimize unnecessary connections to ground. Do not connect any of the following terminals to each other or to earth ground:

- Power supply dc common
- TB1, terminals 5, 6, 11, 12 (analog common)
- TB1, terminal 17 (reference voltage common)
- TB1, terminals 23, 24 (communications common)
- TB2, terminal 2 (dc power common)

Special Precautions for the CLS216

The CLS216 has single-ended inputs. All the negative sensor leads are tied to the analog common. That means there is no sensor-to-sensor isolation. Proper grounding is critical for this unit. Take these additional precautions with a CLS216:

- Use *all* ungrounded or *all* well-grounded thermocouples, not a mix.
- If using a mixture of thermocouples or low-voltage inputs (<500 mV) and current inputs, connect the negative leads of the current transmitters to terminal 17 (Ref Com) on TB1.
- If using voltage transmitters, use only sourcing models or configuration. Sinking configurations will not work.
- Isolate the controller's communication port (if used) by using an optically isolated 232-to-485 converter.

Personal Computers and Ground Loops

Many PC communications ports connect the communications common to chassis ground. When such a PC is connected to the controller, this can provide a path to ground for current from the process that can enter the controller through a sensor (such as a thermocouple). This creates a ground loop that can affect communications and other controller functions. To eliminate a ground loop, either use an optically isolated communications adapter or take measures to ensure that sensors and all other connections to the controller are isolated and not conducting current into the unit.

Power Connections

This section covers making the power connections to the CLS200 and connecting the TB50.

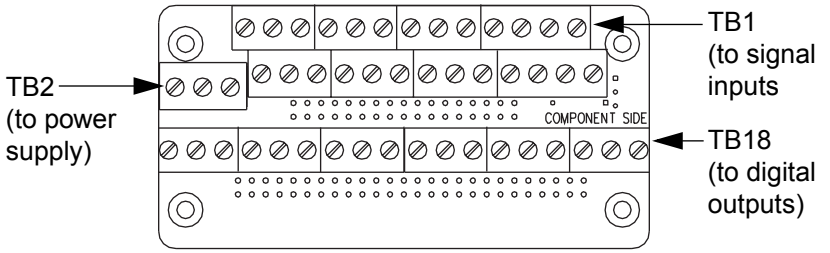


Figure 2.12 CLS200 Series Controller with TB18

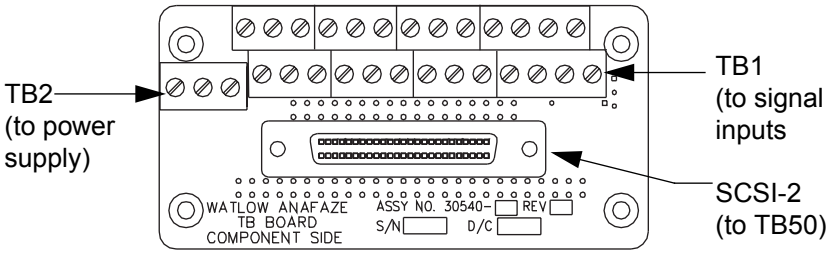


Figure 2.13 CLS200 Series Controller with TB50

Wiring the Power Supply

WARNING! ***Use a power supply with a Class 2 rating only. UL approval requires a Class 2 power supply.***

Connect power to the controller before any other connections, This allows you to ensure that the controller is working before any time is taken installing inputs and outputs.

Table 2.2 Power Connections

Function	Power Supply	CLS200 TB2
DC Power (Controller)	+12 to 24V⎓ (dc)	+
DC Common	12 to 24V⎓ (dc) Common	-
Earth Ground	Ground	⏚

1. Connect the dc common terminal on the power supply to the dc common (-) terminal on CLS200 TB2.
2. Connect the positive terminal on the power supply to the dc positive (+) terminal on CLS200 TB2.
3. If using an isolated dc output or another power supply to power the loads, connect the dc common of the supply powering the loads to the dc common of the supply powering the controller.
4. Use the ground connector on TB2 for chassis ground. This terminal is connected to the CLS200 chassis and must be connected to earth ground.
5. Connect 120/240V~ (ac) power to the power supply.

NOTE! ***Connect the dc common of the power supply used for loads to the dc common of the supply powering the controller. If the supplies are not referenced to one another, the controller's outputs will not be able to switch the loads.***

NOTE! ***When making screw terminal connections, tighten to 4.5 to 5.4 inch-pound (0.5 to 0.6 Nm).***

⚠

CAUTION! ***Without proper grounding, the CLS200 may not operate properly or may be damaged.***

CAUTION! ***To prevent damage from incorrect connections, do not turn on the ac power before testing the connections as explained in Testing Your System on page 28.***

NOTE! ***Do not connect the controller's dc common (COM) to earth ground ⏚. Doing so will defeat the noise protection circuitry, making measurements less stable.***

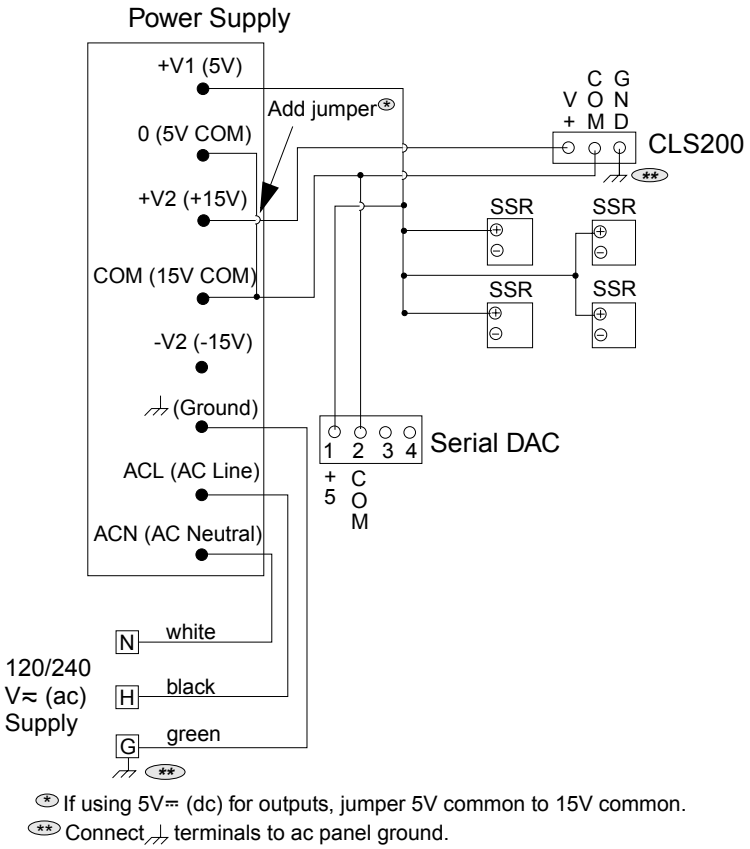


Figure 2.14 Power Connections with the CLS200 Power Supply

Connecting TB50 to CLS200

1. Connect the SCSI cable to the controller.
2. Connect the SCSI cable to the TB50.

Testing Your System

This section explains how to test the controller after installation and prior to making field wiring connections.

TB50 or TB18 Test

Use this procedure to verify that the TB50 or TB18 is properly connected and supplied with power:

1. Turn on power to the CLS200. The display should read `CALCULATING CHECKSUM` then show the bar graph display. *(See Figure 3.3.)* If you do not see these displays, disconnect power and check wiring and power supply output.
2. Measure the +5V⎓ (dc) supply at the TB50 or TB18:
   a) Connect the voltmeter's common lead to TB50 or TB18 terminal 3 or TB18 terminal 2.
   b) Connect the voltmeter's positive lead to TB50 or TB18 screw terminal 1. The voltage should be +4.75 to +5.25V⎓ (dc).

Digital Output Test

Use this procedure to test the controller's outputs before loads are connected. If using it at another time for troubleshooting, disconnect loads from outputs before testing.

1. Connect a 500 Ω to 100 kΩ resistor between TB50 or TB18 screw terminal 1 and a digital output terminal. (*See Table 2.5, TB18 Connections on page 40; Table 2.6, TB50 Connections for CLS204 and CLS208 on page 41;* or *Table 2.7, TB50 Connections for CLS216 on page 42.)*
2. Connect the voltmeter's positive lead to screw terminal 1.
3. Connect the common lead to the digital output terminal.
4. Use the digital output test in the `MANUAL I/O TEST` menu to turn the digital output on and off. *(See Test Digital Output on page 104* and *Digital Output Number on page 104.*) When the output is `ON`, the output voltage should be less than 1V. When the output is `OFF`, the output voltage should be between 4.75 and 5.25V.

NOTE! ***By default, heat outputs are enabled. Only disabled outputs may be turned on using the manual I/O test. To test heat outputs, set the corresponding loop to manual mode 100% output. See Selecting the Control Status on page 61.***

Digital Input Test

Use the following procedure to test digital inputs before connecting to field devices:

1. Disconnect any system wiring from the input to be tested.
2. Go to the DIGITAL INPUTS test in the MANUAL I/O TEST menu. (*See Digital Inputs on page 103.*) This test shows whether the digital inputs are H (high, or open) or L (low, or closed).
3. Attach a wire to the terminal of the digital input you want to test. See tables *2.5* to *2.7* on pages 40 to 42 for connections.
   a) When the wire is connected only to the digital input terminal, the digital input test should show that the input is H (high, or open).
   b) When you connect the other end of the wire to the controller common (TB50 terminal 3 or TB18 terminal 2), the digital input test should show that the input is L (low, or closed).

Sensor Wiring

This section describes how to properly connect thermocouples, RTDs, current and voltage inputs to your controller. The controller can accept any mix of available input types. Some input types require that special scaling resistors be installed (generally done by Watlow Anafaze before the controller is delivered).

All inputs are installed at the CH input connectors (TB1) at the back of the controller. The illustrations below show the connector locations for all the CLS200 series controllers.

CAUTION! ***Never run input leads in bundles with high power wires or near other sources of EMI. This could inductively couple voltage onto the input leads and damage the controller, or could induce noise and cause poor measurement and control.***

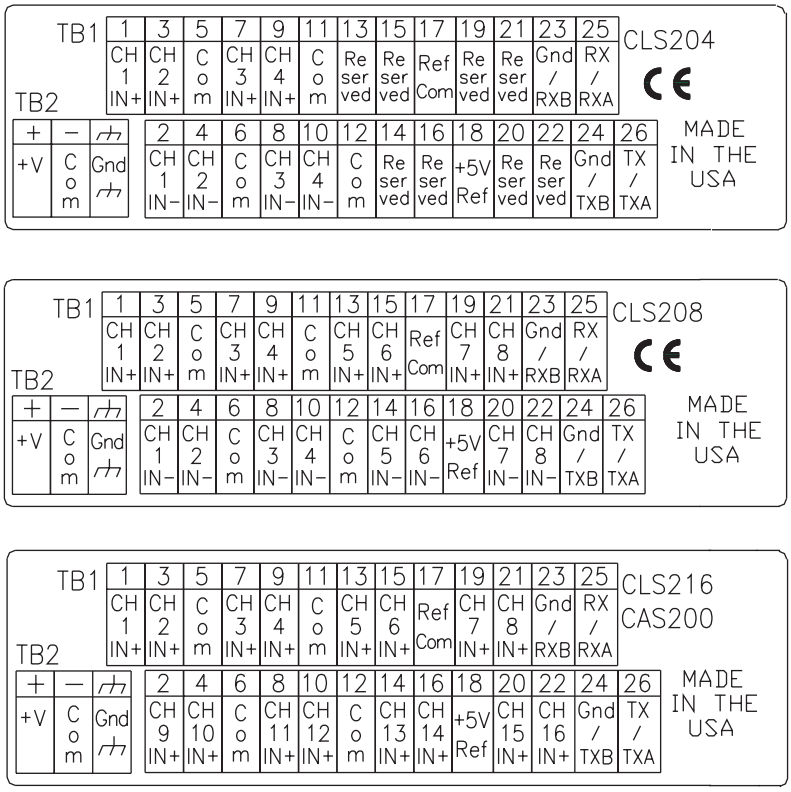


Figure 2.15 CLS200 Connector Locations

Input Wiring Recommendations

Use multicolored stranded shielded cable for analog inputs. Watlow Anafaze recommends that you use 20 AWG wire (0.5 mm^2). If the sensor manufacturer requires it, you can also use 24 or 22 AWG wiring (0.2 mm^2). Most inputs use a shielded twisted pair; some require a 3-wire input.

Follow the instructions pertaining to the type(s) of input(s) you are installing.

The controller accepts the following inputs without any special scaling resistors:

- J, K, T, S, R, B and E thermocouples.
- Linear inputs with ranges between -10 and 60 mV.

Any unused inputs should be set to `SKIP` or jumpered to avoid thermocouple break alarms.

Thermocouple Connections

Connect the positive lead of any of the supported thermocouple types to the IN+ terminal for one of the loops and the negative lead to the corresponding IN- terminal.

Use 18 or 20 AWG (0.5 or 0.75 mm^2) for all the thermocouple inputs. Most thermocouple wire is solid, unshielded wire. When using shielded wire, ground one end only.

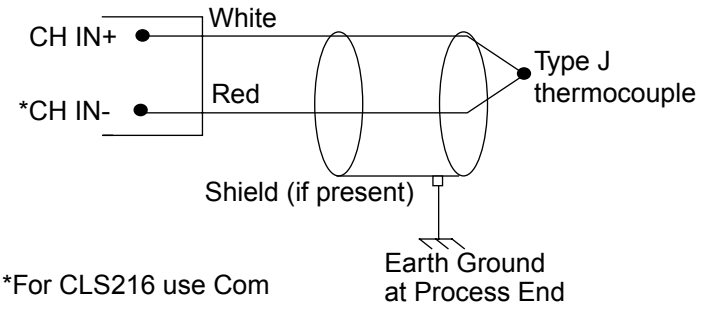


Figure 2.16 Thermocouple Connections

NOTE! ***When mixing current inputs with low-voltage inputs (thermocouples or voltage inputs <1V) to a CLS216, connect the current signal to the IN+ and Ref Com terminals. If no low-voltage sensors are used, connect current inputs to the IN+ and Com terminals on TB1. For all inputs to a CLS204 or CLS208, connect the sensors to the IN+ and Com terminals.***

CAUTION! ***Ground loops and common mode noise can damage the controller or disrupt measurements. To minimize ground loops and common mode noise:***

• With a CLS216, use only ungrounded thermocouples with each thermocouple sheath electrically connected to earth ground. The negative sensor terminals on the CLS216 are tied to analog common.

• With a CLS204 or CLS208, do not mix grounded and ungrounded thermocouples. If any thermocouple connected to the controller is of grounded construction, all thermocouples should be of grounded construction

and each should be connected to ground at the process end.

• Connect the earth ground terminal on TB2 to a good earth ground, but do not connect the analog common to earth ground. The CLS200 uses a floating analog common for sensor measurements. The noise protection circuits on the sensor inputs function correctly only when the controller is correctly installed. See Ground Loops on page 24.

RTD Input Connections

This input type requires scaling resistors. Watlow Anafaze recommends that you use a 100 Ω, 3-wire platinum RTD to prevent reading errors due to cable resistance. If you use a 2-wire RTD, jumper the negative input to common. If you must use a 4-wire RTD, leave the fourth wire unconnected.

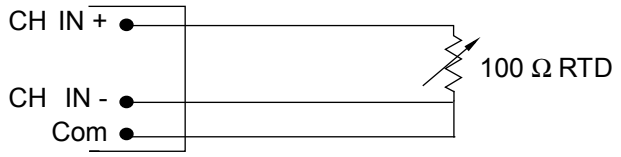


Figure 2.17 RTD Connections to CLS204 or CLS208

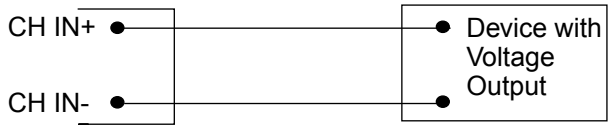
Reference Voltage Terminals

The +5V Ref and Ref Com terminals are provided in order to power external bridge circuits for special sensors. Do not connect any other types of devices to these terminals.

Voltage Input Connections

This input type requires scaling resistors. Special input resistors installed at Watlow Anafaze divide analog input voltages such that the controller sees a -10 to 60 mV signal on the loop.

CLS204 and CLS208



CLS216

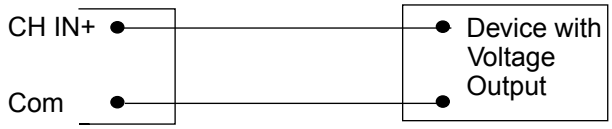
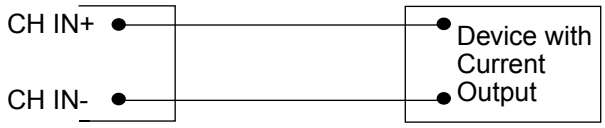


Figure 2.18 Linear Voltage Signal Connections

Current Input Connections

This input type requires scaling resistors. Special input resistors installed at Watlow Anafaze for analog current signals are such that the controller sees a -10 to 60 mV signal across its inputs for the loop.

CLS204 and CLS208



CLS216

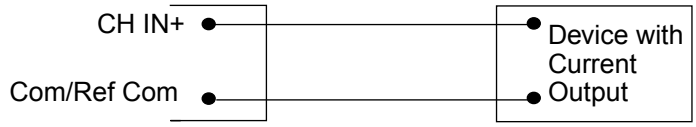


Figure 2.19 Linear Current Signal Connections

NOTE! ***When mixing current inputs with low-voltage inputs (thermocouples or voltage inputs <1V) to a CLS216, connect the current signal to the IN+ and Ref Com terminals. When no low-voltage sensors are used, connect current inputs to the IN+ and Com terminals on TB1. For all inputs to a CLS204 or CLS208, connect the sensors to the IN+ and Com terminals.***

Pulse Input Connections

The CLS200 can accept a pulse input of up to 2000 Hz from a device such as an encoder. The frequency of this input is scaled with user-set parameters. See *Setup Loop Input Menu on page 82* and *Chapter 9, Linear Scaling Examples.* This scaled value is the process variable for loop 5 on a CLS204, loop 9 on a CLS208, or loop 17 on a CLS216.

The CLS200 can accommodate encoder signals up to 24V⎓ (dc) using a voltage divider or can power encoders with the 5V⎓ (dc) from the TB50 or TB18. The following figures illustrate connecting encoders. A pull-up resistor in the CLS200 allows open collector inputs to be used.

NOTE! ***If the signal on the pulse input exceeds 10kHz the controller's operation may be disrupted. Do not connect the pulse input to a signal source that may exceed 10kHz.***

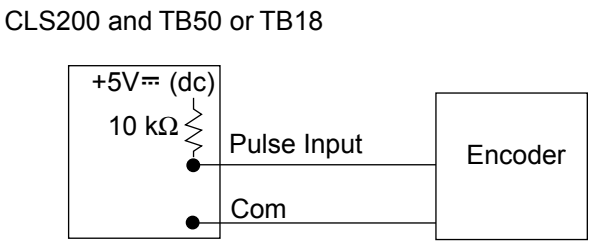


Figure 2.20 Encoder with 5V⎓ (dc) TTL Signal

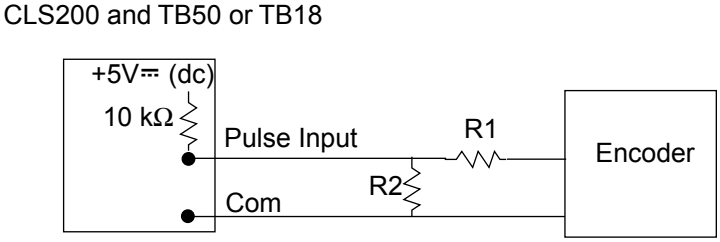


Figure 2.21 Encoder Input with Voltage Divider

For encoders with signals greater than 5V⎓ (dc), use a voltage divider to drop the voltage to 5 volts at the input. Use appropriate values for R_1 and R_2 depending on the encoder excitation voltage. Be sure not to exceed the specific current load on the encoder.

Wiring Control and Digital I/O

This section describes how to wire and configure the control outputs for the CLS200 series controller.

NOTE! ***Control outputs are connected to the CLS200's common when the control output is on (low). Be careful when you connect external devices that may have a low side at a voltage other than controller ground, since you may create ground loops.***

If you expect grounding problems, use isolated solid state relays and isolate the control device inputs.

The CLS200 provides dual PID control outputs for each loop. These outputs can be enabled or disabled, and are connected via TB50 or TB18.

Output Wiring Recommendations

When wiring output devices, use multicolored, stranded, shielded cable for analog outputs and digital outputs connected to panel-mounted solid state relays.

- Analog outputs usually use a twisted pair.
- Digital outputs usually have 9 to 20 conductors, depending on wiring technique.

Cable Tie Wraps

Once you have wired outputs to the TB50, install the cable tie wraps to reduce strain on the connectors.

Each row of terminals has a cable tie wrap hole at one end. Thread the cable tie wrap through the cable tie wrap hole. Then wrap the cable tie wrap around the wires attached to that terminal block.

Digital Outputs

The CLS200 series provides dual control outputs for up to 16 loops. The controller's default configuration has all heat outputs enabled and all cool outputs disabled. Disabling a heat output makes that output available to be used as a control or an alarm output. See *Enable or Disable Heat or Cool Outputs on page 94*. The CPU watchdog timer output can be used to monitor the state of the controller with an external circuit or device. See *CPU Watchdog Timer on page 38*.

Table 2.3 Digital Output States and Values Stored in the Controller

State	Value	Description
Off	High	Open circuit
On	Low	Sinking current to common

The digital outputs sink current from the load to the controller common. The load may powered by the 5V⎓ (dc) supplied by the controller at the TB50. Alternately, an external power supply may be used to drive loads.

Keep in mind the following points when using an external power supply:

- The CLS200 power supply available from Watlow Anafaze includes a 5V⎓ (dc) supply. When using it to supply output loads, connect the 5V⎓ (dc) common to the 15V⎓ (dc) common at the power supply.
- Do not exceed +24 volts.
- If you tie the external load to earth ground, or if you cannot connect it as shown in *(See Figure 2.22)*, then use a solid-state relay.

All digital outputs are sink outputs referenced to the CLS200 series controller common supply. These outputs are low (pulled to common) when they are on.

The outputs conduct current when they are low or on. The maximum current sink capability is 60 mA at 24V⎓ (dc). They cannot "source" current to a load.

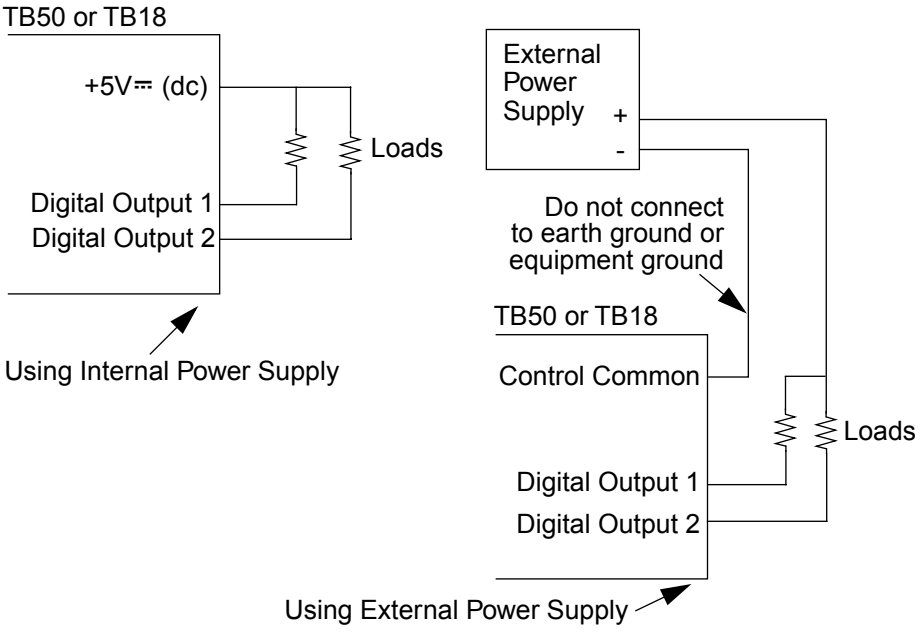


Figure 2.22 Digital Output Wiring

Configuring Outputs

Keep in mind the following points as you choose outputs for control and alarms:

- You can enable or disable the control outputs. The default setting is heat outputs enabled, cool outputs disabled.
- You can program each control output individually for on/off, time proportioning, distributed zero crossing, or Serial DAC control.
- You can individually program each control output for direct or reverse action.
- Alarm outputs other than the global alarm are non-latching.
- Alarms can be suppressed during process start up and for preprogrammed durations. See *Alarm Delay on page 103*.
- Alarm outputs can be configured as a group as normally on (low) or normally off (high). See *Digital Output Polarity on Alarm on page 81*.

Control and Alarm Output Connections

Typically control and alarm outputs use external optically isolated solid state relays (SSRs). SSRs accept a 3 to 32V⎓ (dc) input for control, and some can switch up to 100 Amps at 480 V~ (ac). For larger currents, use silicon control rectifier (SCR) power controllers up to 1000 Amps at 120 to 600V~ (ac). You can also use SCRs and a Serial DAC for phase-angle fired control.

The 34 control and alarm outputs are open collector outputs referenced to the CLS200's common. Each output sinks up to 60 mA⎓ (dc) to the controller common when on.

NOTE! ***Control outputs are SINK outputs. They are Low when the output is ON. Connect them to the negative side of solid state relays.***

Figure 2.23 shows sample heat, cool and alarm output connections.

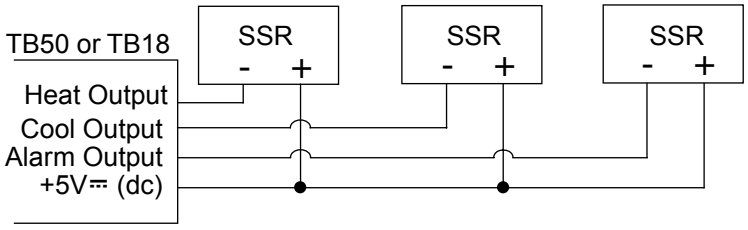


Figure 2.23 Sample Heat, Cool and Alarm Output Connections

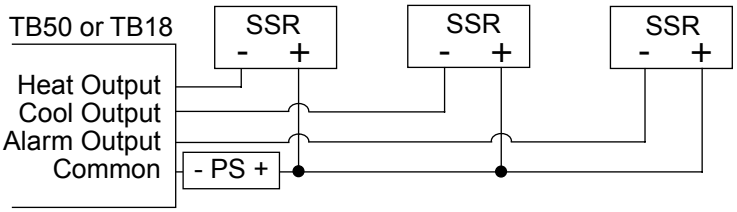


Figure 2.24 Output Connections Using External Power Supply

CPU Watchdog Timer

The CPU watchdog timer constantly monitors the microprocessor. It is a sink output located on TB50 terminal 6 or TB18 terminal 3. The output can be connected to an external circuit or device in order to determine if the controller is powered and operational. Do not exceed 5V⎓ (dc), 10 mA⎓ (dc) rating for the watchdog output. The output is low (on) when the microprocessor is operating; when it stops operating, the output goes high (off).

Figure 2.25 and *Figure 2.26* show the recommended circuit for the watchdog timer output for the TB50 and the TB18.

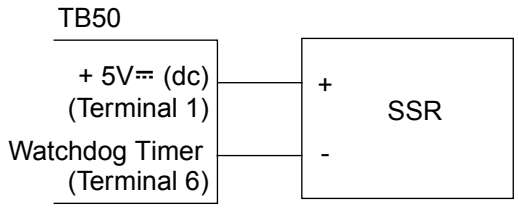


Figure 2.25 TB50 Watchdog Timer Output

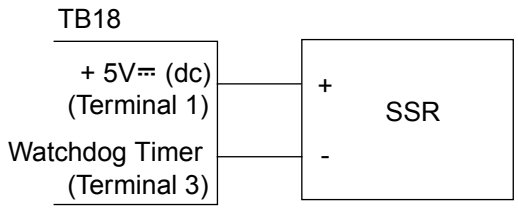


Figure 2.26 TB18 Watchdog Timer Output

Digital Inputs

All digital inputs are transistor-transistor logic (TTL) level inputs referenced to control common and the internal +5V power supply of the CLS200.

When an input is connected to the controller common, the input is considered on. Otherwise, the input is considered

off. Most features that use the digital inputs can be user-configured to activate when an input is either on or off.

In the off state, internal 10 k resistors pull the digital inputs high to 5V⎓ (dc) with respect to the controller common.

Table 2.4 Digital Inputs States and Values Stored in the Controller

State	Value	Description
Off	High	Open circuit
On	Low	Digital Input connected to controller common

External Switching Devices

To ensure that the inputs are reliably switched, use a switching device with the appropriate impedances in the on and off states and do not connect the inputs to external power sources.

When off, the swiching device must provide an impedance of at least 11 kΩ to ensure that the voltage will rise to greater than 3.7V⎓ (dc). When on, the switch must provide not more than 1 kΩ impedance to ensure the voltage drops below 1.3V⎓ (dc).

To install a switch as a digital input, connect one lead to the common terminal on the TB50 (terminals 3 and 4) or TB18 (terminal 2). Connect the other lead to the desired digital input terminal on the TB50 (terminals 43 to 50) or TB18 (terminals 16 to 18).

Functions Activated by Digital Inputs

Use digital inputs to activate the following functions:

- Load a job that is stored in controller memory. *See Job Select Digital Inputs on page 76.*
- Change all loops to manual mode at specified output levels. *See Output Override Digital Input on page 77.*
- Enable thermocouple short detection. *See Process Power Digital Input on page 79.*
- Restore control automatically after a failed sensor has been repaired. *See Restore PID Digital Input on page 92.*

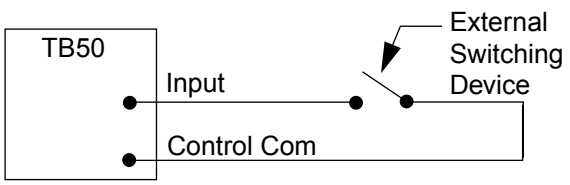


Figure 2.27 Wiring Digital Inputs

TB18 Connections (CLS204 and CLS208 Only)

Table 2.5 TB18 Connections

		Control Output[1]	
Terminal	**Function**	**CLS204**	**CLS208**
1	+5V⎓ (dc)		
2	CTRL COM		
3	Watchdog timer		
4	Global alarm		
5	Output 1	Loop 1 heat	Loop 1 heat
6	Output 2	Loop 2 heat	Loop 2 heat
7	Output 3	Loop 3 heat	Loop 3 heat
8	Output 4	Loop 4 heat	Loop 4 heat
9	Output 5	Pulse loop heat	Loop 5 heat
10	Output 6	Loop 1 cool	Loop 6 heat
11	Output 7	Loop 2 cool	Loop 7 heat
12	Output 8	Loop 3 cool	Loop 8 heat
13	Output 9	Loop 4 cool	Pulse loop heat
14	Output 10	Pulse loop cool	Loop 1 cool
15	Output 34[2]	Serial DAC clock	Serial DAC clock
16	Input 1		
17	Input 2		
18	Input 3/Pulse input		

[1] The indicated outputs are dedicated for control when enabled in the loop setup. If one or both of a loop's outputs are disabled, the corresponding digital outputs become available for alarms or ramp/soak events.

[2] If you install a Watlow Anafaze Serial DAC, the CLS200 series controller uses digital output 34 for a clock line. You cannot use output 34 for anything else when you have a Serial DAC installed.

TB50 Connections

Table 2.6 TB50 Connections for CLS204 and CLS208

		Control Output[1]				Control Output[1]	
Terminal	**Function**	**CLS208**	**CLS204**	**Terminal**	**Function**	**CLS208**	**CLS204**
1	+5V⎓ (dc)			2	+5V⎓ (dc)		
3	CTRL COM			4	CTRL COM		
5	Not Used			6	Watchdog Timer		
7	Pulse Input			8	Global Alarm		
9	Output 1	Loop 1 heat	Loop 1 heat	10	Output 34[2]		
11	Output 2	Loop 2 heat	Loop 2 heat	12	Output 33		
13	Output 3	Loop 3 heat	Loop 3 heat	14	Output 32		
15	Output 4	Loop 4 heat	Loop 4 heat	16	Output 31		
17	Output 5	Loop 5 heat	Pulse loop heat	18	Output 30		
19	Output 6	Loop 6 heat	Loop 1 cool	20	Output 29		
21	Output 7	Loop 7 heat	Loop 2 cool	22	Output 28		
23	Output 8	Loop 8 heat	Loop 3 cool	24	Output 27		
25	Output 9	Pulse loop heat	Loop 4 cool	26	Output 26		
27	Output 10	Loop 1 cool	Pulse loop cool	28	Output 25		
29	Output 11	Loop 2 cool		30	Output 24		
31	Output 12	Loop 3 cool		32	Output 23		
33	Output 13	Loop 4 cool		34	Output 22		
35	Output 14	Loop 5 cool		36	Output 21		
37	Output 15	Loop 6 cool		38	Output 20		
39	Output 16	Loop 7 cool		40	Output 19		
41	Output 17	Loop 8 cool		42	Output 18	Pulse loop cool	
43	Input 1			44	Input 2		
45	Input 3			46	Input 4		
47	Input 5			48	Input 6		
49	Input 7			50	Input 8		

[1] The indicated outputs are dedicated for control when enabled in the loop setup. If one or both of a loop's outputs are disabled, the corresponding digital outputs become available for alarms or ramp/soak events.

[2] If you install a Watlow Anafaze Serial DAC, the controller uses digital output 34 (terminal 10) for a clock line. You cannot use output 34 for anything else when you have a Serial DAC installed.

Table 2.7 TB50 Connections for CLS216

Terminal	Function	CLS216 Control Output[1]	Terminal	Function	CLS216 Control Output[1]
1	+5V⎓ (dc)		2	+5V⎓ (dc)	
3	CTRL COM		4	CTRL COM	
5	Not Used		6	Watchdog Timer	
7	Pulse Input		8	Global Alarm	
9	Output 1	Loop 1 heat	10	Output 34[2]	Pulse loop cool
11	Output 2	Loop 2 heat	12	Output 33	Loop 16 cool
13	Output 3	Loop 3 heat	14	Output 32	Loop 15 cool
15	Output 4	Loop 4 heat	16	Output 31	Loop 14 cool
17	Output 5	Loop 5 heat	18	Output 30	Loop 13 cool
19	Output 6	Loop 6 heat	20	Output 29	Loop 12 cool
21	Output 7	Loop 7 heat	22	Output 28	Loop 11 cool
23	Output 8	Loop 8 heat	24	Output 27	Loop 10 cool
25	Output 9	Loop 9 heat	26	Output 26	Loop 9 cool
27	Output 10	Loop 10 heat	28	Output 25	Loop 8 cool
29	Output 11	Loop 11 heat	30	Output 24	Loop 7 cool
31	Output 12	Loop 12 heat	32	Output 23	Loop 6 cool
33	Output 13	Loop 13 heat	34	Output 22	Loop 5 cool
35	Output 14	Loop 14 heat	36	Output 21	Loop 4 cool
37	Output 15	Loop 15 heat	38	Output 20	Loop 3 cool
39	Output 16	Loop 16 heat	40	Output 19	Loop 2 cool
41	Output 17	Pulse loop heat	42	Output 18	Loop 1 cool
43	Input 1		44	Input 2	
45	Input 3		46	Input 4	
47	Input 5		48	Input 6	
49	Input 7		50	Input 8	

[1] The indicated outputs are dedicated for control when enabled in the loop setup. If one or both of a loop's outputs are disabled, the corresponding digital outputs become available for alarms or ramp/soak events.

[2] If you install a Watlow Anafaze Serial DAC, the controller uses digital output 34 (terminal 10) for a clock line. You cannot use output 34 for anything else when you have a Serial DAC installed.

Analog Outputs

Analog outputs can be provided by using a Dual DAC or Serial DAC module to convert the open collector outputs from the controller. Use multicolored stranded shielded cable for analog outputs. Analog outputs generally use a twisted pair wiring. The following sections describe how to connect the Dual DAC and Serial DAC modules to power the controller outputs and the load.

Wiring the Dual DAC

A Dual DAC module includes two identical circuits. Each can convert a distributed zero-cross (DZC) signal from the controller to a voltage or current signal. Watlow Anafaze strongly recommends using a power supply separate from the controller supply to power the Dual DAC. Using a separate power supply isolates the controller's digital logic circuits and analog measurement circuits from the frequently noisy devices that take the analog signal from the Dual DAC.

Several Dual DAC modules may be powered by one power supply. Consult the *Specifications* chapter for the Dual DAC's power requirements. Also note in the specifications that the Dual DAC does not carry the same industry approvals as the Serial DAC.

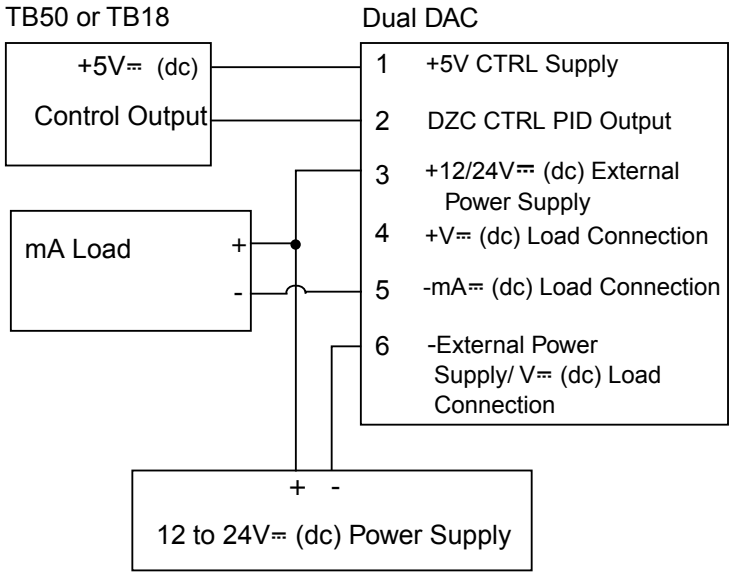


Figure 2.28 Dual DAC with Current Output

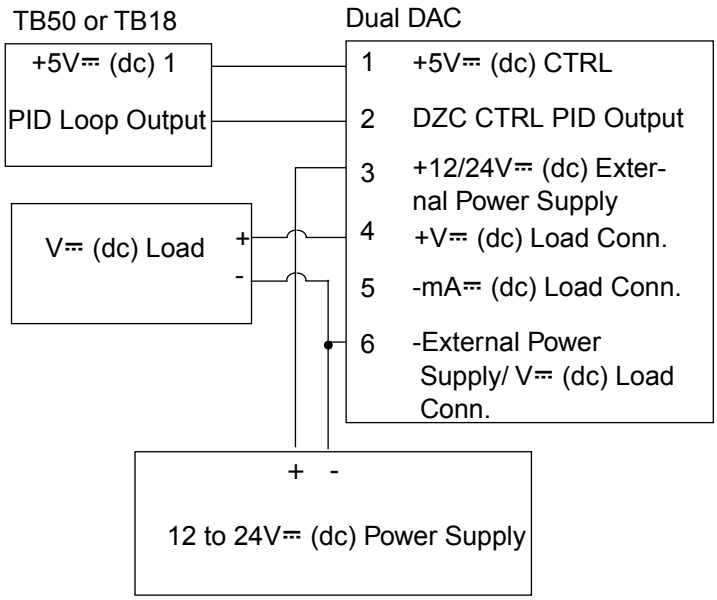


Figure 2.29 Dual DAC with Voltage Output

Wiring the Serial DAC

The Serial DAC provides a robust analog output signal. The module converts the proprietary Serial DAC signal from the controller's open collector output in conjunction with the clock signal to an analog current or voltage. See *Figure 2.30* for wiring. The Serial DAC is user-configurable for voltage or current output through firmware configuration. See *Configuring Serial DAC Outputs on page 188*.

The Serial DAC optically isolates the controller's control output from the load. When a single Serial DAC is used, it may be powered by the 5V⎓ (dc) found on the TB50, or by an external supply referenced to the controller's power supply. When using multiple Serial DACs, the controller cannot provide sufficient current; use the 5V⎓ (dc) output from the CLS200 power supply

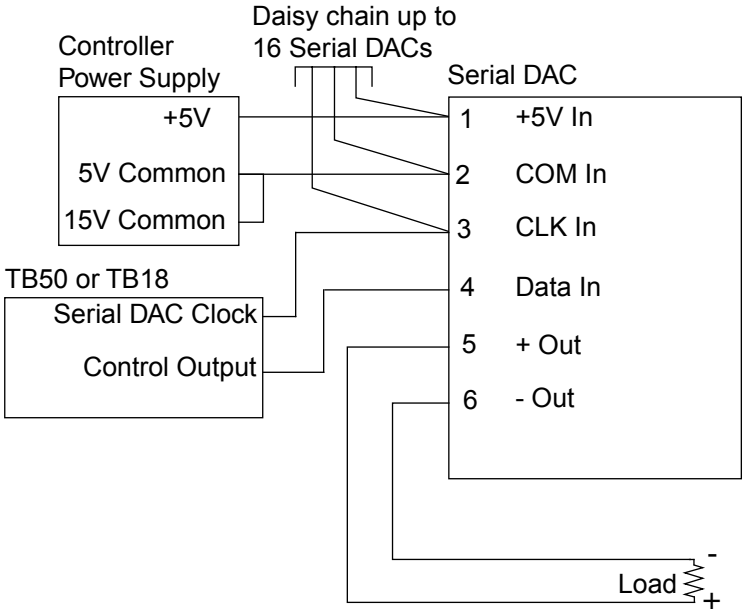


Figure 2.30 Single/Multiple Serial DACs

Serial Communications

The CLS200 series controllers are factory-configured for EIA/TIA-232 communications unless otherwise specified when purchased. However, the communications are jumper-selectable, so you can switch between EIA/TIA-232 and EIA/TIA-485. See *Changing Communications on page 179.*

EIA/TIA-232 Interface

EIA/TIA-232 provides communication to the serial port of an IBM PC or compatible computer. It is used for single-controller installations where the cable length does not exceed 50 feet (15.2 m).

The EIA/TIA-232 interface is a standard three-wire interface. See the table below for connection information.

If you are using EIA/TIA-232 communications with grounded thermocouples, use an optical isolator between the controller and the computer to prevent ground loops.

Table 2.8 shows EIA/TIA-232 connections for 25-pin and 9-pin connectors or cables that are supplied by the factory.

EIA/TIA-232 may be used to connect a computer through a 232/485 converter, to an EIA/TIA-485 communications network with up to 32 CLS200 controllers.

Table 2.8 EIA/TIA-232 Connections

Wire Color	CLS200 TB1	DB 9 Connector	DB 25 Connector
White	TX Pin 26	RX Pin 2	RX Pin 3
Red	RX Pin 25	TX Pin 3	TX Pin 2
Black	GND Pin 23	GND Pin 5	GND Pin 7
Green	GND Pin 24	N/U Pin 9	N/U Pin 22
Shield	N/C	GND Pin 5	GND Pin 7

Jumpers in EIA/TIA-232 Connectors

Some software programs and some operator interface terminals require a Clear to Send (CTS) signal in response to their Request to Send (RTS) signal, or a Data Set Ready (DSR) in response to their Data Terminal Ready (DTR). The CLS200 is not configured to receive or transmit these signals. To use such software with the CLS200, jumper the RTS to the CTS and the DTR to the DSR in the DB connector. *Table 2.9* lists the standard pin assignments for DB-9 and DB-25 connectors.

Table 2.9 RTS/CTS Pins in DB-9 and DB-25 Connectors

	DB-9	DB-25
RTS	7	4
CTS	8	5
DTR	4	20
DSR	6	6

Cables manufactured by Watlow Anafaze for EIA/TIA-232 communications include these jumpers. Neither AnaWin nor Anasoft software requires these jumpers.

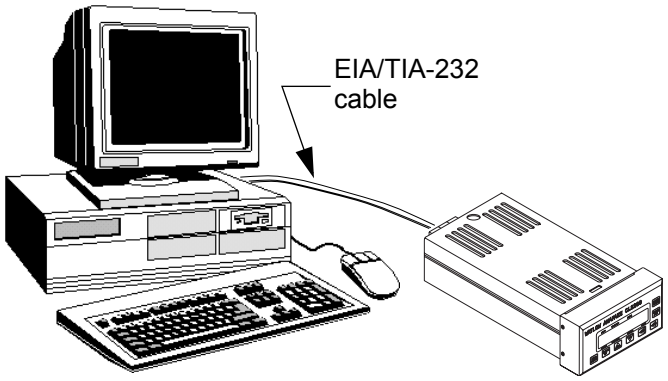


Figure 2.31 Connecting One CLS200 to a Computer Using EIA/TIA-232

EIA/TIA-485 Interface

To communicate with more than one CLS200 series controller on a controller network, or to use communication cable lengths greater than 50 feet (15.2 m) from PC to controller, you must use EIA/TIA-485 communications.

When using EIA/TIA-485 communications, you must attach an optically isolated EIA/TIA-232 to EIA/TIA-485 converter to the computer.

Figure 2.32 and *Figure 2.33* show the recommended system wiring. To avoid ground loops, use an optically isolated EIA/TIA-232 to EIA/TIA-485 converter between the computer and the EIA/TIA-485 network.

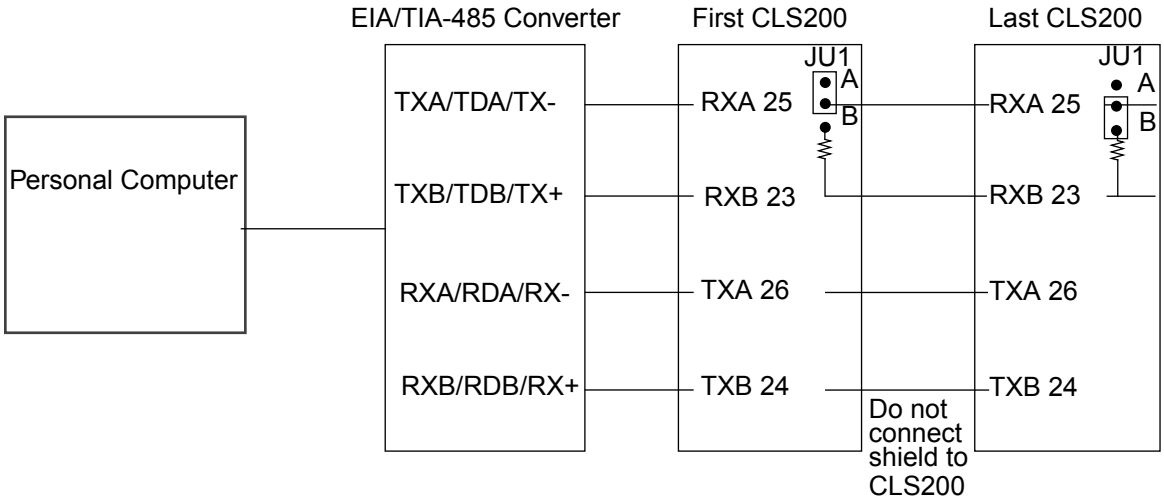


Figure 2.32 EIA/TIA-485 Wiring

Cable Recommendations

Watlow Anafaze recommends Belden 9843 cable or its equivalent. This cable includes three 24 AWG (0.2 mm^2) shielded, twisted pairs. It should carry signals of up to 19.2k baud with no more than acceptable losses for up to 4,000 feet (1,220 m).

EIA/TIA-485 Network Connections

Walow Anafaze recommends that you use a single daisy chain configuration rather than spurs. Run a twisted-pair cable from the host or the converter to the first CLS200, and from that point run a second cable to the next CLS200, and so on. (See *Figure 2.33.)*

If necessary for servicing, instead of connecting each controller directly into the next, install a terminal strip or connector as close as possible to each CLS200, run a communications cable from one terminal strip to the next and connect the controllers to the bus with short lengths of cable.

To avoid unacceptable interference, use less than 10 feet (3 m) of cable from the terminal or connector to the CLS200 serial port.

Some systems may experience problems with sensor signal reading if the commons of multiple controllers are connected. See *Signal Common on page 48*.

Refer to *Termination on page 48* for more on terminating resistors.

Connect the shield drain to earth ground only at computer or host end.

.

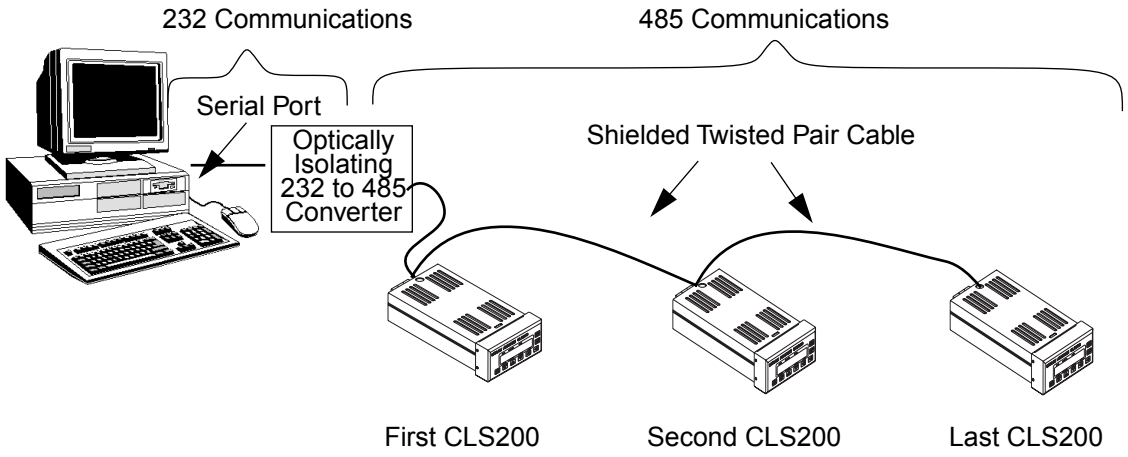


Figure 2.33 Recommended System Connections

Signal Common

For usual installations, do not connect the dc commons of the controllers together or to the converter or host device. Use an optically isolating EIA/TIA-232-to-485 converter to prevent problems with sensor readings.

Termination

In order for EIA/TIA-485 signals to be transmitted properly, each pair must be properly terminated. The value of the termination resistor should be equal to the impedance of the communications cable used. Values are typically 150 to 200 Ω.

The receive lines at the converter or host device should be terminated in the converter, the connector to the host device or the device itself. Typically the converter documentation provides instructions for termination.

Use a terminating resistor on the receive lines on the last controller on the 485 line. Set JU1 inside the CLS200 in position B to connect a 200 Ω resistor across the receive lines. Refer to *Changing Communications on page 179*.

EIA/TIA-485 Converters and Laptop Computers

In order for an EIA/TIA-232-to-485 converter to optically isolate the computer from the 485 network, the 232 and 485 sides must be powered independently. Many 232-to-485 converters can be powered by the computer's communications port. Some computers, laptops in particular, do not automatically provide the appropriate voltages. These computer/converter combinations can usually be used by connecting an external power supply to the 232 side of the converter. Not all converters have power inputs for the 232 side, however.

NOTE! ***When using Anasoft with a laptop computer, choose a converter with an external 232 power input. AnaWin and Watview works with all tested converters without an external 232 input.***

3

Using the CLS200

This chapter explains how to use the keypad and display to operate the controller. *Figure 3.1* shows the operator menus and displays accessible from the front panel.

To change global parameters, loop inputs, control parameters, outputs, and alarms using the setup menus, see *Chapter 4, Setup*.

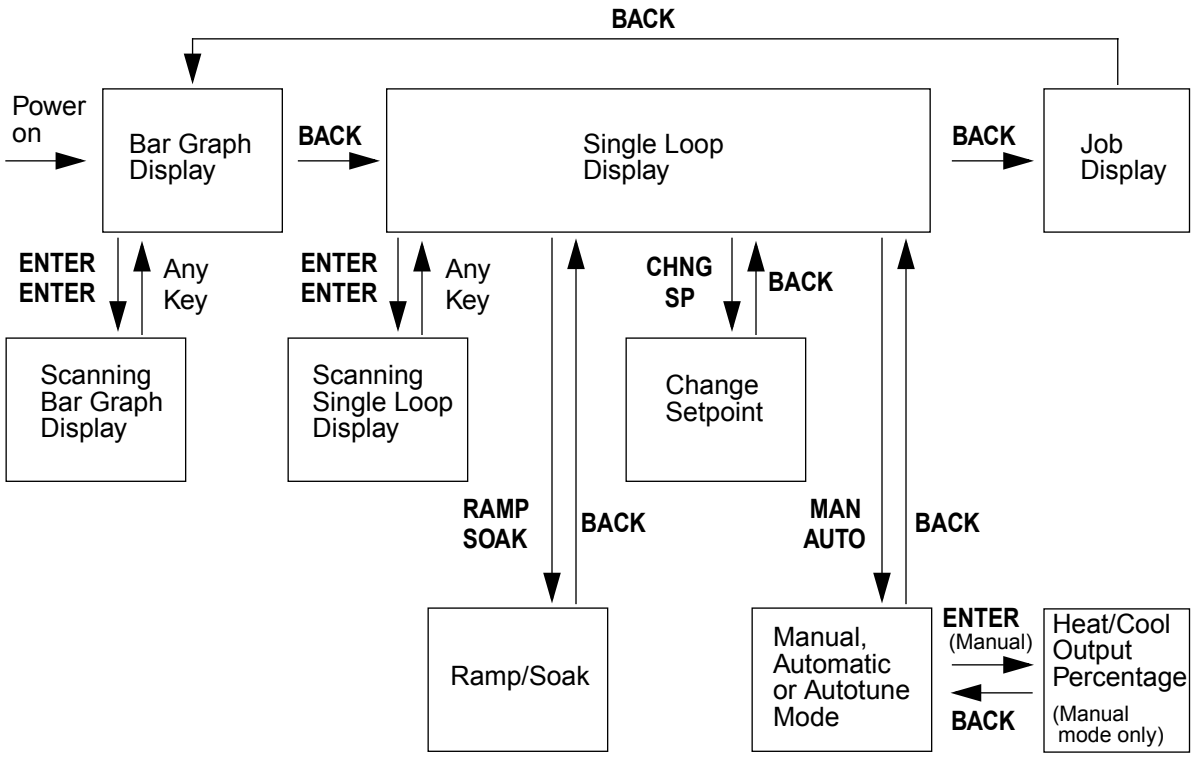


Figure 3.1 Operator Displays

Front Panel

The CLS200 front panel provides a convenient interface with the controller. You can use the front panel keys to program and operate the CLS200.

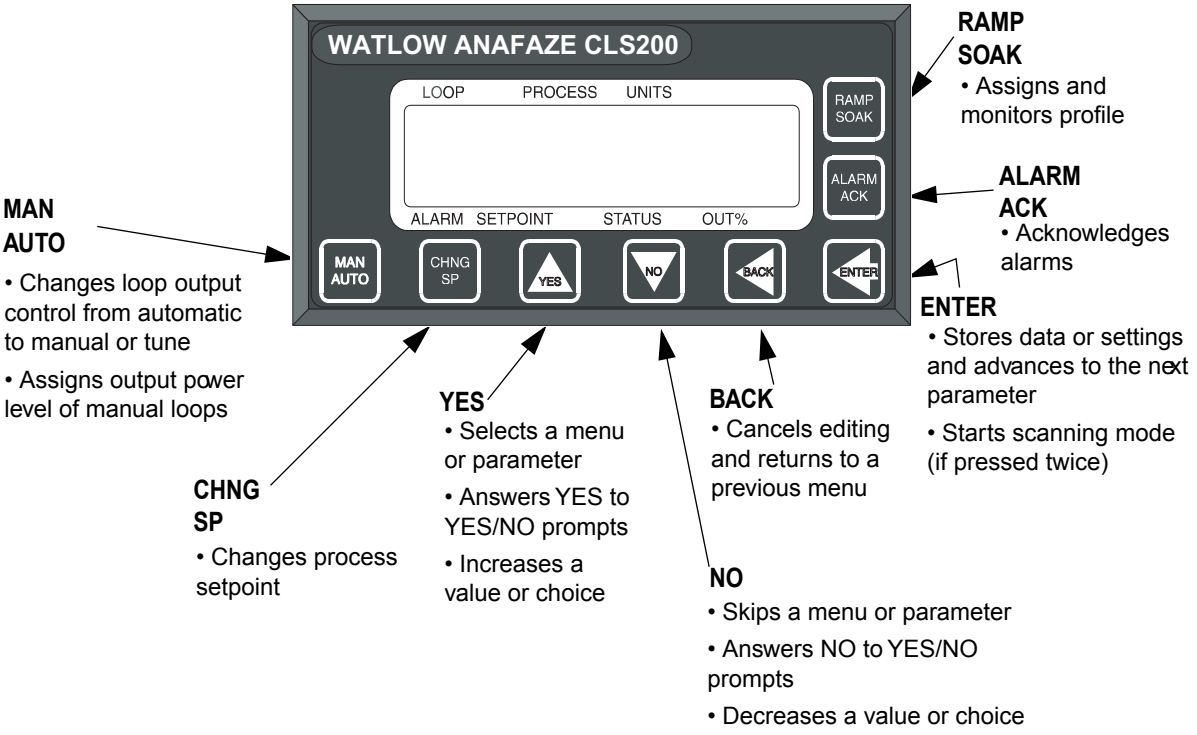


Figure 3.2 CLS200 Front Panel

Front Panel Keys

YES (up)

Press **YES** to:

- Select a menu or parameter
- Answer **YES** to the flashing ? prompts
- Increase a value or choice when editing
- Stop scanning mode

NO (down)

Press **NO** to:

- Skip a menu or parameter when the prompt is blinking
- Answer **NO** to the flashing ? prompts
- Decrease a value or choice when editing
- Stop scanning mode
- Perform a **NO**-key reset

NOTE! ***Pressing the NO key on power up performs a NO-key reset. This procedure clears the RAM and sets the controller's parameters to their default values. See NO-Key Reset on page 176.***

BACK

Press **BACK** to:

- Cancel editing
- Return to a previous menu
- Switch between bar graph, single loop and job displays
- Stop scanning mode

ENTER

Press **ENTER** to:

- Store data or a parameter choice after editing and go to the next parameter
- Start scanning mode (if pressed twice)

CHNG SP

Press **CHNG SP** to change the loop setpoint

MAN AUTO

Press **MAN/AUTO** to:

- Toggle a loop between manual and automatic control
- Adjust the output power level of manual loops
- Automatically tune the loop

RAMP SOAK

If your controller has the ramp/soak option, press **RAMP/ SOAK** to:

- Assign a ramp/soak profile to the current loop
- Select the ramp/soak mode
- See the status of a running profile

Your controller may not have the ramp/soak option. If it does not, pressing the **RAMP/SOAK** key displays the message `OPTION UNAVAILABLE`.

ALARM ACK

Press **ALARM ACK** to:

- Acknowledge an alarm condition
- Reset the global alarm output

Displays

This section discusses the controller's main displays: bar graph, single loop and job.

Bar Graph Display

On power up, the controller displays general symbolic information for up to eight loops. This screen is called the bar graph display. The diagram below shows the symbols used in the bar graph display.

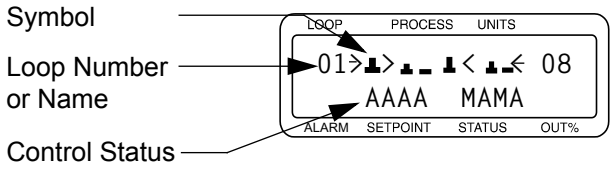


Figure 3.3 Bar Graph Display

Table 3.1 explains the symbols you see on the top line of the bar graph display. These symbols appear when the controller is in dual output mode (heat and cool outputs enabled) and single output mode (heat or cool outputs enabled, but not both).

Table 3.1 Bar Graph Display Symbols

Symbol	Description
<	Loop is in low process or low deviation alarm.
>	Loop is in high process or high deviation alarm.
▟▙▟	Loop is above setpoint. If you enable the high or low deviation alarm, this symbol is scaled to it. If you do not enable these alarms, these symbols are scaled to the setpoint ±5% of the sensor's range.
▬	Loop is at setpoint. If you enable the high or low deviation alarm, this symbol is scaled to it. If you do not enable these alarms, these symbols are scaled to the setpoint ±5% of the sensor's range.
▀▀▀	Loop is below setpoint. If you enable the high or low deviation alarm, this symbol is scaled to it. If you do not enable these alarms, these symbols are scaled to the setpoint ±5% of the sensor's range.
(blank)	Loop's input type is set to SKIP.
F	Open thermocouple (T/C), shorted T/C, reversed T/C, open RTD or shorted RTD.

Table 3.2 explains the control status symbols on the bottom line of bar graph display. Additional symbols may appear with the ramp/soak option. *See Bar Graph Display on page 146*.

Table 3.2 Control Status Symbols on the Bar Graph and Single Loop Displays

Bar Graph Display Symbol	Single Loop Display Symbol	Description
M	MAN	One or both outputs are enabled. Loop is in manual control.
A	AUTO	Only one output (heat or cool) is enabled. Loop is in automatic control.
T	TUNE	The loop is in autotune mode.
H T	HEAT	Both heat and cool outputs are enabled. Loop is in automatic control and heating.
C L	COOL	Both heat and cool outputs are enabled. Loop is in automatic control and cooling.
(blank)	(blank)	Both outputs disabled, or input type is set to SKIP.

Navigating in Bar Graph Display

When the bar graph display is visible:

- Press the **YES** (up) or **NO** (down) key to see a new group of loops.
- Press **ENTER** twice to scan all groups of loops. The groups will display sequentially for three seconds each. This is called scanning mode.
- Press any key to stop scanning.
- Press **BACK** once to go to the job display, if enabled, or the single loop display.

Single Loop Display

The single loop display shows detailed information for one loop at a time.

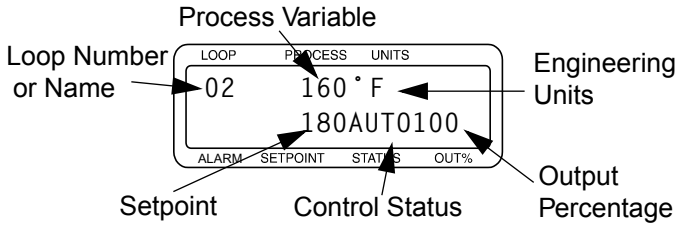


Figure 3.4 Single Loop Display

The control status indicator shows MAN, AUTO or TUNE modes.

If both control outputs for a loop are enabled and the loop is in automatic control, then the single loop display shows HEAT or COOL as the control status:

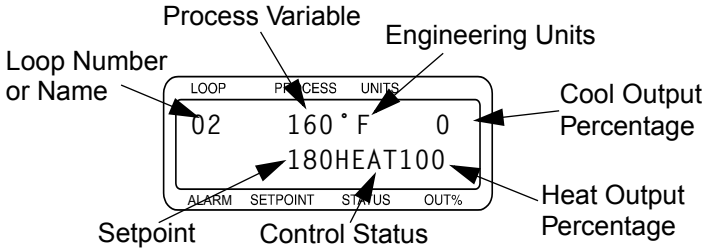


Figure 3.5 Single Loop Display, Heat and Cool Outputs Enabled

Navigating the Single Loop Display

In the single loop display:

- Press **YES** to go to the next loop.
- Press **NO** to go to the previous loop.
- Press **BACK** once to go to the job display (if enabled) or bar graph display.
- Press **ENTER** twice to start the single loop scanning display. The single loop scanning display shows information for each loop in sequence. Data for each loop displays for one second.
- Press any key to stop scanning.

Alarm Displays

If a process, deviation, failed or system sensor alarm occurs, the controller switches from any Single Loop display or Bar Graph display to the Single Loop display for the loop with the alarm. The global alarm output turns on and a two-character alarm code appears in the lower left corner of the Single Loop display. If the alarm is for a failed sensor, a short message appears in place of the process variable and units. Control outputs associated with failed sensors are set to the value of the SENSOR FAIL HT/CL OUTPUT % parameter (default, 0%). The alarm code blinks and displays cannot be changed until the alarm has been acknowledged. Once the alarm is acknowledged, the alarm code stops blinking. When the condition that caused the alarm is corrected, the alarm messages disappear.

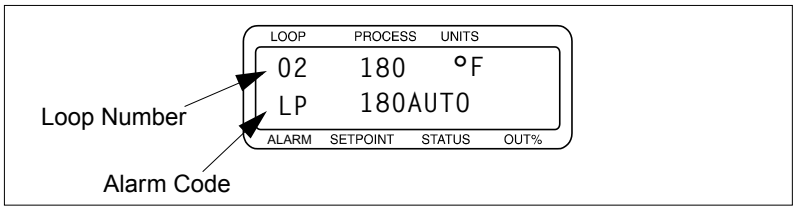


Figure 3.6 Single Loop Display with a Process Alarm

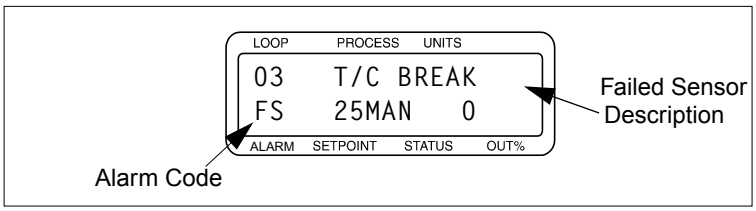


Figure 3.7 Failed Sensor Alarm in the Single Loop Display

Alarms that still exist but have been acknowledged are displayed on the Bar Graph display. A letter or symbol indicates the alarm condition. *See Table 3.3 on page 59* for a full list of alarm codes, failed sensor messages and alarm symbols.

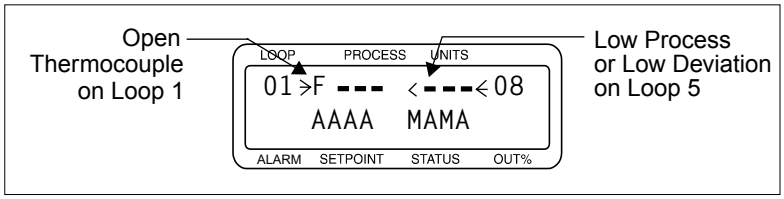

Open Thermocouple on Loop 1
Low Process or Low Deviation on Loop 5
LOOP PROCESS UNITS
01 >F --- <---< 08
AAAA MAMA
ALARM SETPOINT STATUS OUT%

Figure 3.8 Alarm Symbols in the Bar Graph Display

Table 3.3 shows the symbols used in each form of the alarm display.

Table 3.3 Alarm Type and Symbols

Alarm Code	Bar Graph Symbol	Alarm Message	Alarm Description
FS	F	T/C BREAK	Failed Sensor: Break detected in thermocouple circuit.
RO	F	RTD OPEN	RTD Open: Break detected in RTD circuit.
RS	F	RTD SHORTED	RTD Short: Short detected in RTD circuit.
RT	F	REVERSED TC	Reversed Thermocouple: Reversed polarity detected in thermocouple circuit.
ST	F	T/C SHORTED	Shorted Thermocouple: Short detected in thermocouple circuit.
HP	>	No message	High Process Alarm: Process variable has risen above the set limit.
HD	>	No message	High Deviation Alarm: Process variable has risen above the setpoint plus the deviation alarm value.
LP	<	No message	Low Process Alarm: Process variable has dropped below the set limit.
LD	<	No message	Low Deviation Alarm: Process variable has dropped below the setpoint minus the deviation alarm value.
AW	*	No message	Ambient Warning: Controller's ambient temperature has exceeded operating limits by less than 5° C.

Acknowledging an Alarm

Press **ALARM ACK** to acknowledge the alarm. If there are other loops with alarm conditions, the Alarm display switches to the next loop in alarm. Acknowledge all alarms to clear the global alarm digital output (the keypad and display won't work for anything else until you acknowledge each alarm). The alarm symbols are displayed as long as the alarm condition is valid.

System Alarms

When a system alarm occurs, the global alarm output turns on and an alarm message appears on the display. The message continues to be displayed until the error condition is removed and the alarm is acknowledged. The CLS200 can display the following system alarms:

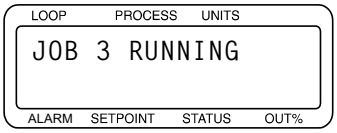
- BATTERY DEAD
  See Battery Dead on page 168.
- LOW POWER
  See Low Power on page 168.
- AW
  See Ambient Warning on page 168.
- H/W FAILURE: AMBIENT
  See H/W Ambient Failure on page 169.
- H/W FAILURE: GAIN
  See H/W Gain or Offset Failure on page 170.
- H/W FAILURE: OFFSET
  See H/W Gain or Offset Failure on page 170.

Job Display

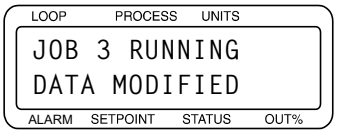
The job display appears only if:

- You have enabled JOB SELECT DIG INPUTS. (*See Load Setup From Job on page 75.)*
  – and –
- You have selected a job from the job load menu.

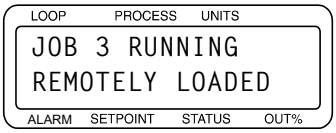
After loading a job using the LOAD SETUP FROM JOB menu, the job display shows you the following screen:



If parameters are modified while the job is running, this screen will display:

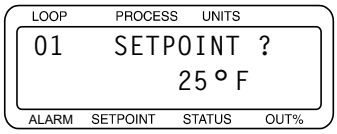


If the job was loaded using digital inputs, the display shows:



Changing the Setpoint

Select the single loop display for the loop you want to change. Press CHNG SP. This display appears:



- Press **YES** to change the setpoint.

Press the up or down keys (**YES** or **NO**) to increase or decrease the setpoint value.

- Press **ENTER** to save your changes and return to single loop display.
  – or –
  Press **NO** or **BACK** (without pressing **ENTER**) to return to single loop display without saving the new setpoint.

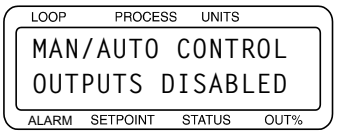
Selecting the Control Status

If you set the control status to **AUTO**, the controller automatically controls the process according to the configuration information you give it.

If you set the control status to **MAN**, you need to set the output level.

If you set the control status to **TUNE**, the controller performs an autotune and chooses PID parameters.

NOTE! ***If the loop outputs are disabled, you cannot toggle between manual and automatic control. If you try it, the screen shows an error message telling you that the outputs are disabled, as shown below. Use the SETUP LOOPS OUTPUT menu to enable the outputs. See Setup Loop Outputs Menu on page 93.***



Manual and Automatic Control

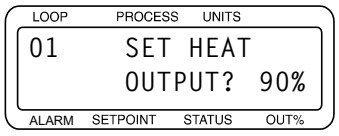
1. Switch to the single loop display for the loop.
2. Press **MAN/AUTO**.
3. Press **YES** to change the mode
   – or –
   if the mode is **MAN**, press **NO** to set the output power.

Go to the next subsection, *Manual Output Levels*.
– or –
press **NO** if in **AUTO** to cancel and remain in **AUTO** mode.

4. Select a mode by pressing the up or down key **(YES** or **NO)** to scroll through the modes.
5. Press **ENTER** to make the mode change
   – or –
   press **BACK** to return to the single loop display without saving the new mode setting.
6. If you set the loop to manual, you are prompted for the output power. Go to *Manual Output Levels* below.

Manual Output Levels

If the loop to is set to manual control, the controller prompts for output levels for the enabled control outputs. Use this menu to set the manual heat and cool output levels. You should see a display like this:



1. Press **YES** to change the output power level. (If the heat outputs are enabled, you will be able to change the heat output power level. If only the cool outputs are enabled, you will be able to change only the cool output power level.)
   – or –
   Press **NO** to go to the cool output, if available, and then press **YES** to change the cool output.
2. Press up or down **(YES** or **NO)** to select a new output power level.
3. Press **ENTER** to store your changes
   – or –
   press **BACK** to discard your changes and return to single loop display.
4. Repeat from *Step 1* for the cool output, if available.
5. Press **BACK** at any time to discard your changes and return to single loop display.

Autotuning a Loop

Autotuning is a process by which a controller determines the correct PID parameters for optimum control. This section explains how to autotune the CLS200.

Prerequisites

Before autotuning the controller, it must be installed with control and sensor circuitry and the thermal load in place.

It must be safe to operate the thermal system, and the approximate desired operating temperature (setpoint) must be known.

The technician or engineer performing the autotune should know how to use the controller front panel or MMI software interface (e.g., AnaWin or Anasoft) to do the following:

1. Select a loop to operate and monitor.
2. Set a loop's setpoint.
3. Change a loop's control status (**MAN**, **TUNE**, **AUTO**).
4. Read and change the controller's global and loop setup parameters.

Background

Autotuning is performed at the maximum allowed output. If you have set an output limit, autotuning occurs at that value. Otherwise, the control output is set to 100% during the autotune. Only the heat output (output 1) of a loop may be autotuned.

The PID constants are calculated according to process's response to the output. The loop need not reach or cross setpoint to successfully determine the PID parameters. While autotuning the controller looks at the delay between when power is applied and when the system responds in order to determine the proportional band (PB). The controller then looks for the slope of the rising temperature to become constant in order to determine the integral term (TI). The derivative term (TD) is derived mathematically from the TI.

When the controller has finished autotuning, the loop's control status switches to **AUTO**. If the process reaches 75% of the setpoint or the autotuning time exceeds ten minutes, the controller switches to **AUTO** and applies the PID constants it has calculated up to that point.

The Watlow Anafaze autotune is started at ambient temperature or at a temperature above ambient. However, the temperature must be *stable* and there must be sufficient time for the controller to determine the new PID parameters.

Performing an Autotune

NOTE! ***A loop must be stable at a temperature well below the setpoint in order to successfully autotune. The controller will not complete tuning if the temperature exceeds 75% of setpoint before the new parameters are found.***

The following procedure explains how to autotune a loop:

1. Select the single loop display of the loop to be tuned.

2. Ensure the loop's process variable is stable and the loop is in **MAN** control status.
3. Set the setpoint to a value as near the normal operating temperature as is safe for the system.

WARNING! ***During autotuning, the controller will set the output to 100% until the process variable rises near the setpoint. Set the setpoint within the safe operating limits of your system.***

4. Use the three-key sequence (**ENTER, ALARM ACK, CHNG SP**) to access the setup menus. In the `SETUP LOOP INPUT` menu, locate the `INPUT FILTER` parameter. Note the setting and then change it to `0 SCANS`.
5. Press the **BACK** key until the single loop display appears.
6. Press the **MAN/AUTO** key.
7. Press the **NO** key to toggle to the **TUNE** mode.
8. Press the **ENTER** key to begin tuning the loop. **TUNE** flashes throughout the tuning process. When tuning is completed the control status indicator changes to **AUTO**.
9. Adjust the setpoint to the desired temperature.
10. Restore the `INPUT FILTER` parameter to its original value.

Using Alarms

The CLS200 has three main types of alarms:

- Failed sensor alarms
- Process alarms
- System alarms

Alarm Delay

You can set the controller to delay normal alarm detection and alarm reporting. There are two kinds of alarm delay:

- Start-up alarm delay delays process alarms (but not failed sensor alarms) for all loops for a time period you set at the `STARTUP ALARM DELAY` parameter in the `SETUP GLOBAL PARAMETERS` menu.
- Loop alarm delay delays failed sensor alarms and process alarms for one loop until the alarm condition is continuously present for longer than the loop alarm delay time you set.

Failed sensor alarms are affected by the loop alarm delay even during the start-up alarm delay time period.

Failed Sensor Alarms

Failed sensor alarms alert you if one of the following conditions occurs:

- Thermocouple open
- Thermocouple shorted (must be enabled)
- Thermocouple reversed (must be enabled)
- RTD open positive input or open negative input
- RTD short between the positive and negative inputs

What Happens if a Failed Sensor Alarm Occurs?

If a failed sensor alarm occurs:

- The controller switches to manual mode at the output power indicated by the SENSOR FAIL HT OUTPUT and SENSOR FAIL CL OUTPUT parameters in the SETUP LOOP OUTPUTS menu. (The output power may be different for a thermocouple open alarm; *see Thermocouple Open Alarm on page 65*.)
- The controller displays an alarm code and alarm message on the display. See *Alarm Displays on page 58*.
- The global alarm output is activated.

Thermocouple Open Alarm

The thermocouple open alarm occurs if the controller detects a break in a thermocouple or its leads.

If a thermocouple open alarm occurs, the controller switches to manual mode. The output level is determined as follows:

- If the HEAT/COOL T/C BRK OUT parameter in the SETUP LOOP OUTPUTS menu is set to ON, then the controller sets the output power to an average of the recent output.
- If the HEAT/COOL T/C BRK OUT AVG parameter is set to OFF, then the controller sets the output to the level indicated by the SENSOR FAIL HT/CL OUTPUT parameter in the SETUP LOOP OUTPUTS menu.

Thermocouple Reversed Alarm

The thermocouple reversed alarm occurs if the temperature goes in the opposite direction and to the opposite side of ambient temperature than expected—for example, a loop is heating and the measured temperature drops below the ambient temperature.

The thermocouple reversed alarm is disabled by default. To enable this alarm, set the REVERSED T/C DETECT parameter in the SETUP LOOP INPUTS menu to **ON**. It may be disabled if false alarms occur in your application.

Thermocouple Short Alarm

The thermocouple short alarm occurs if the process power is on and the temperature does not rise or fall as expected. To enable the thermocouple short alarm, you must do the following:

- Choose a digital input for the PROCESS POWER DIGIN parameter in the SETUP GLOBAL PARAMETERS menu.
- Connect the digital input to a device that connects the input to controller common when the process power is on.

RTD Open or RTD Shorted Alarm

The RTD open alarm occurs if the controller detects that the positive or negative RTD lead is broken or disconnected.

The RTD shorted alarm occurs if the controller detects that the positive and negative RTD leads are shorted.

You do not have to set any parameters for the RTD alarms.

Restore Automatic Control After a Sensor Failure

This feature returns a loop to automatic control after a failed sensor is repaired. To enable this feature:

- Choose a digital input for the RESTORE PID DIGIN parameter in the SETUP LOOP CONTROL PARAMS menu.
- Connect the digital input to the dc common terminal on the controller.

Process Alarms

The CLS200 has four process alarms, each of which you can configure separately for each loop:

- Low process alarm
- High process alarm
- Low deviation alarm
- High deviation alarm

Setting Up Alarms

To set up an alarm:

- Set the alarm setpoint (limit)
- Set the alarm type
- Choose an output, if desired
- Set the alarm deadband
- Set an alarm delay, if desired

The setpoints, deviation alarm values, and deadband all use the same decimal format as the loop's process variable.

What Happens If a Process Alarm Occurs?

If a process alarm occurs, the controller does the following:

- Shows an alarm code on the display. *(See Alarm Displays on page 58.)* .
- Activates the global alarm output. *(See Global Alarm on page 68.)*
- Activates the digital output that is assigned to the process alarm (if applicable). The digital output remains active until the process variable returns within the corresponding limit and deadband. The alarm output deactivates when the process returns to normal.

Process Alarm Outputs

Any digital output that is not used as a control output can be assigned to one or more process alarms.

The controller activates the output if any alarm assigned to the output is active. Process alarm outputs are non-latching—that is, the output is deactivated when the process returns to normal, whether or not the alarm has been acknowledged.

Specify the active state of process alarm outputs at the DIG OUT POLARITY ON ALARM setting in the SETUP GLOBAL PARAMETERS.

Alarm Type: Control or Alarm

You can configure each process alarm as either a control or alarm.

- Alarm configuration provides traditional alarm functionality: The operator must acknowledge the alarm message on the controller display, a latching global alarm is activated, and the alarm can activate a user-specified non-latching alarm output.
- Control configuration provides on/off control output using the alarm setpoints. For example, you could configure a high deviation alarm to turn on a fan. The alarm activates a user-specified non-latching output. Alarm messages do not have to be acknowledged, and the global alarm is not activated.

High and Low Process Alarms

A high process alarm occurs if the process variable rises above a user-specified value. A low process alarm occurs if the process variable drops below a separate user-specified value. See *Figure 3.9*.

Enter the alarm high and low process setpoints at the HI PROC ALARM SETPT and LO PROC ALARM SETPT parameters in the SETUP LOOP ALARMS menu.

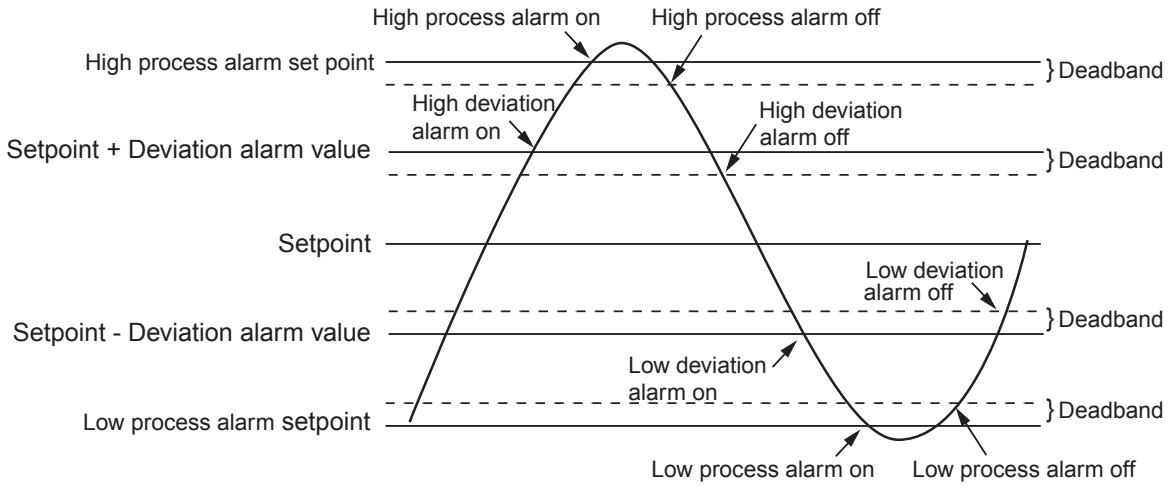


Figure 3.9 Activation and Deactivation of Process Alarms

Deviation Alarms

A deviation alarm occurs if the process deviates from setpoint by more than a user-specified amount. *(See Figure 3.9.)* Set the deviation with the DEV ALARM VALUE parameter in the SETUP LOOP ALARMS menu.

Upon power up or when the setpoint changes, the behavior of the deviation alarms depends upon the alarm function:

- If the alarm type parameter is set to **ALARM**, then deviation alarms do not activate until the after the process variable has first come within the deviation alarm band. This prevents nuisance alarms.
- If the alarm type parameter is set to CONTROL, then the deviation output switches on whenever the setpoint and process variable differ by more than the deviation setting, regardless of whether the process variable has been within the deviation band. This allows you to use boost control upon power up and setpoint changes.

Global Alarm

The CLS200 comes equipped with a global alarm output. The global output is activated if one or more of the following conditions occurs:

- A system alarm occurs, or
- A failed sensor alarm occurs and is unacknowledged, or

- A process alarm occurs and is unacknowledged. The global alarm occurs only if the alarm type is set to ALARM in the SETUP LOOP ALARMS menu. (The global alarm does *not* occur if the alarm function is set to CONTROL.)

The global alarm output stays active until all alarms have been acknowledged.

When the global alarm output is active, it conducts current to the controller's dc common. When the global alarm output is not active, it does not conduct current.

NOTE! ***You cannot configure any parameters for the global alarm. The active state of the global alarm output is NOT affected by the*** DIG OUT POLARITY ON ALARM ***polarity parameter in the*** SETUP GLOBAL PARAMETERS ***menu.***

Ramp/Soak

If you have a controller *without* the Ramp/Soak option, pressing the **RAMP/SOAK** key has no effect.

If you have a controller *with* this option installed, see *Chapter 7, Ramp/Soak*.

4

Setup

The setup menus let you change detailed configuration information. This section describes how to set up the controller from menus in the controller firmware. The following information is included in this chapter:

- Accessing the setup menus
- Changing parameter settings
- Description of controller parameters

If you have not set up a CLS200 series controller before, or if you do not know what values to enter, please read *Chapter 8, Tuning and Control*, which contains PID tuning constants and useful starting values.

How to Access the Setup Menus

Use the *three-key sequence* to enter the setup menus:

1. Select the single loop display for the loop you wish to edit.
2. Press **ENTER** then **ALARM ACK** then **CHNG SP** to access the setup menus. Do not press these keys at the same time; press them one at a time.

3. The first setup menu appears.

To prevent unauthorized personnel from accessing setup parameters, the controller reverts to the single loop display if you do not press any keys for three minutes.

How to Change a Parameter

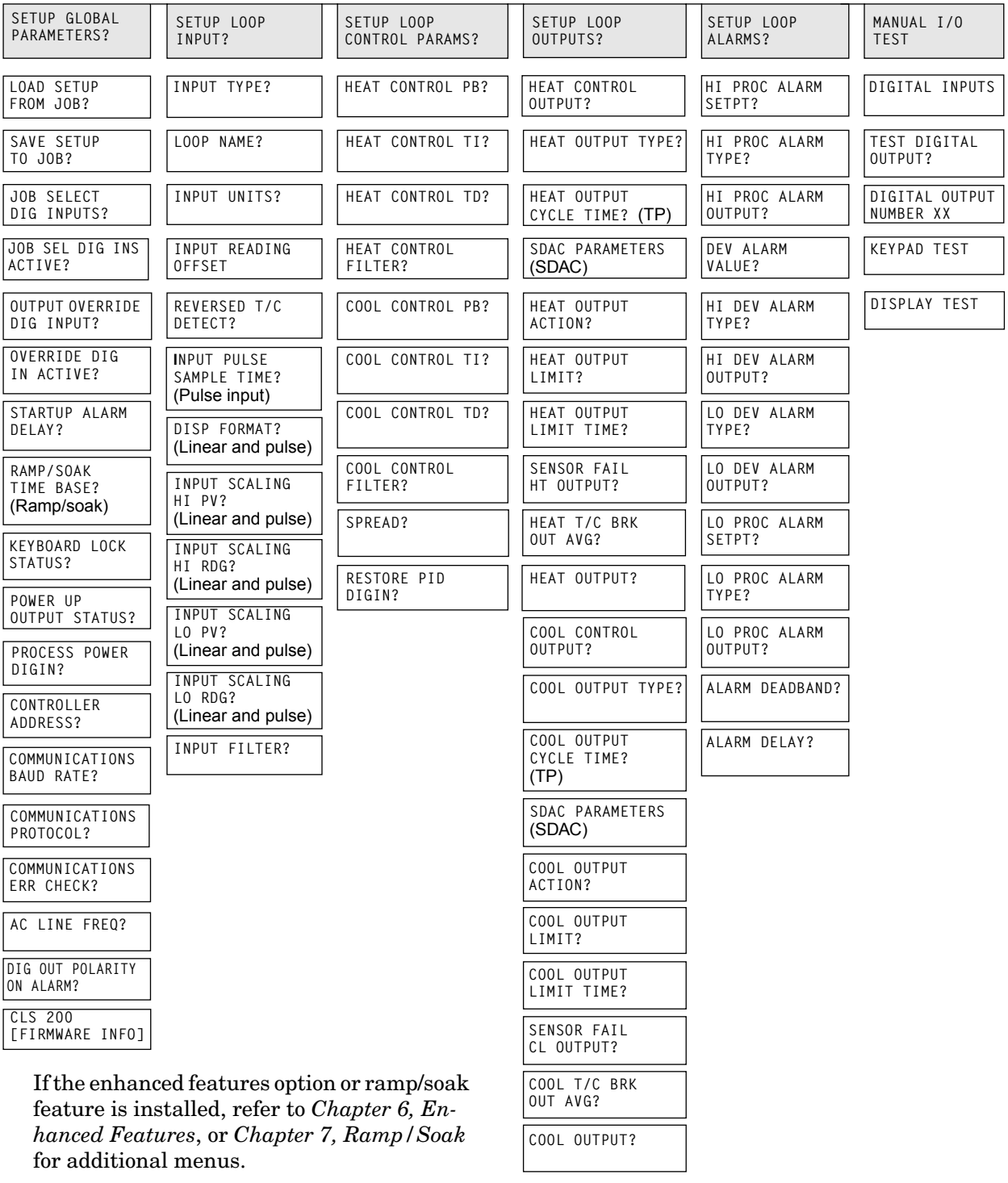
To change a parameter, first select the appropriate menu, then the parameter.

When you enter the setup menus, the first menu is SETUP GLOBAL PARAMETERS. Refer to *Figure 4.1* for a listing of all top level menus and their related parameters.

1. Select the single loop display for the loop to set up.
2. Enter the three-key sequence. (See *How to Access the Setup Menus on page 71.)* The first menu is displayed: SETUP GLOBAL PARAMETERS.
3. To select the appropriate menu:
   - Press **NO** to move from one menu to the next. The menus wrap around; pressing **NO** continuously advances through the top level menus.
   - Press **YES** to enter the displayed menu.
4. To select the parameter to be edited:
   - Press **NO** to advance from one parameter to the next. Parameters do not wrap around.
   - Press **YES** to edit the displayed parameter.
5. To edit the parameter setting:
   - Press up or down (**YES** or **NO**) to scroll to the value or choice you want to select.
   - Press **ENTER** to accept the change
     - or -
     press **BACK** to cancel the change without saving.
6. Select another parameter and repeat from step 4, or press **BACK** to return to the top level menu.
7. Select another menu and repeat from step 3,
   - or -
   press **BACK** to exit the setup menus.

The following sections tell more about the parameters for each of the six top level menus. Each display illustration contains the default value for that specific parameter. If you have a controller with the enhanced features option, there will be additional menus. (See *Chapter 6, Enhanced Features.)*

Figure 4.1 shows the top level menus accessible from the single loop display.



If the enhanced features option or ramp/soak feature is installed, refer to *Chapter 6, Enhanced Features*, or *Chapter 7, Ramp / Soak* for additional menus.

Figure 4.1 CLS200 Menu Tree

Setup Global Parameters Menu

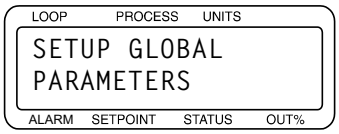


Table 4.1 shows the parameters available in this menu.

Table 4.1 Global Parameters

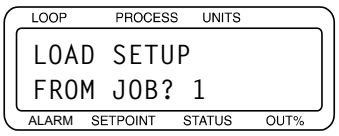
Parameter	Default Value
LOAD SETUP FROM JOB?	1
SAVE SETUP TO JOB?	1
JOB SELECT DIG INPUTS?	NONE
JOB SEL DIG INS ACTIVE?	LOW
OUTPUT OVERRIDE DIG INPUT?	NONE
OVERRIDE DIG IN ACTIVE?	LOW
STARTUP ALARM DELAY?	0 MINS
RAMP/SOAK TIME BASE?*	HOURS/MINS
KEYBOARD LOCK STATUS?	OFF
POWER UP OUTPUT STATUS?	OFF
PROCESS POWER DIGIN?	NONE
CONTROLLER ADDRESS?	1
COMMUNICATIONS BAUD RATE?	9600
COMMUNICATIONS PROTOCOL?	ANA
COMMUNICATIONS ERR CHECK?	BCC
AC LINE FREQ?	60 HERTZ
DIG OUT POLARITY ON ALARM?	LOW
CLS200 [model no., fi mware rev.]	

* The RAMP/SOAK TIME BASE parameter appears only if the ramp/soak feature is installed.

Load Setup From Job

NOTE! ***Current settings are overwritten when you select a job from memory. Save your current settings to another job number if you want to keep them.***

Load any one of eight jobs saved in battery-backed RAM.

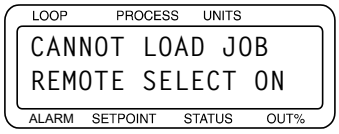


Selectable values: 1 to 8

The following parameters are loaded for each loop as part of a job:

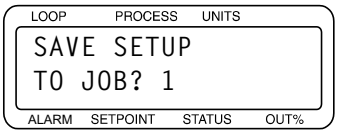
- PID constants, filter settings, setpoints and spread values.
- Loop control status (automatic or manual) and output values (if the loop is in manual control)
- Alarm function (off, alarm control) setpoints, high/low process setpoints, high/low deviation setpoints and deadband settings, and loop alarm delay.

If you have enabled the remote job select function (see *Job Select Digital Inputs on page 76*), you will not be able to load a job. If you try, you will see this message:



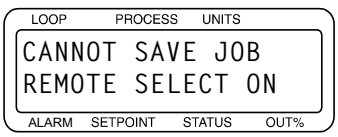
Save Setup to Job

Save the job information for every loop to one of eight jobs in the battery-backed RAM.



Selectable values: 1 to 8

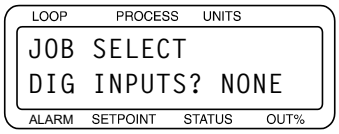
If you have enabled the remote job select function (see *Job Select Digital Inputs on page 76*), you will not be able to save a job. If you try, you will see this message:



Job Select Digital Inputs

Set the number of job select inputs. The controller uses these inputs as a binary code that specifies the job number to run. The number of inputs you choose in this parameter controls the number of jobs you can select remotely.

If you select NONE, digital inputs do not affect job selection. Jobs may be loaded and saved using the LOAD SETUP FROM JOB and SAVE SETUP TO JOB parameters.



Selectable values: 1, 2 or 3 inputs, or NONE. These choices have the following effect:

Table 4.2 Job Select Inputs

Setting	Enables
1	Jobs 1-2
2	Jobs 1-4
3	Jobs 1-8
NONE	Disables remote job selection

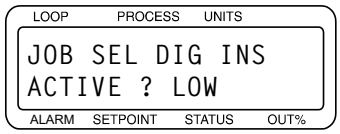
Table 4.3 shows which input states select which jobs. When nothing is connected, the inputs are all false and job 1 is selected.

Table 4.3 Job Selected for Various Input States

Digital Input 3	Digital Input 2	Digital Input 1	Job No.
F	F	F	1
F	F	T	2
F	T	F	3
F	T	T	4
T	F	F	5
T	F	T	6
T	T	F	7
T	T	T	8

Job Select Digital Inputs Active

Specify which state is considered "true" for the digital inputs used for job selection. Default is LOW, meaning that an input must be pulled low to be considered true. If HIGH is selected, an input will be considered true unless it is pulled low.

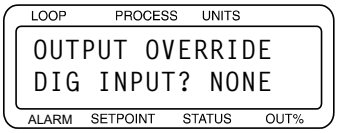


Selectable values: HIGH or LOW.

Changing this setting has the effect of reversing the order of the jobs in *Table 4.3*.

Output Override Digital Input

To enable the output override feature, select a digital input. When the specified input is activated, the controller sets all loops to manual mode at the output levels specified at the SENSOR FAIL HT OUTPUT and SENSOR FAIL CL OUTPUT parameters in the SETUP LOOP OUTPUTS menu.



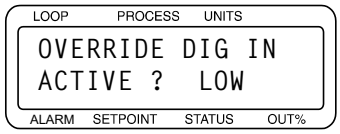
Selectable values: NONE or input number 1 to 8.

Use the next parameter, OVERRIDE DIG IN ACTIVE, to set the signal state that activates the output override feature.

WARNING! ***Do not rely solely on the output override feature to shut down your process. Install external safety devices or over-temperature devices for emergency shutdowns.***

Override Digital Input Active

Specify whether a low or high signal activates the output override feature (see OUTPUT OVERRIDE DIG INPUT above).

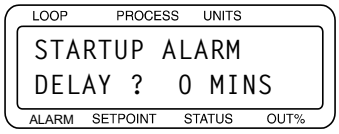


Selectable values: HIGH or LOW.

You can set the input to be active when low or active when high. When the input selected for OUTPUT OVERRIDE DIG INPUT changes to the specified state, all the loop's outputs are set to their sensor fail levels.

Startup Alarm Delay

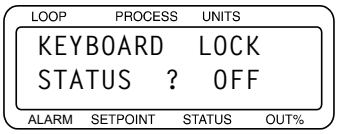
Set a startup delay for process and deviation alarms for all loops. The controller does not report these alarm conditions for the specified number of minutes after the controller powers up. This feature does not delay failed sensor alarms.



Selectable values: 0 to 60 minutes.

Keyboard Lock Status

Set this parameter to ON to disable the **CHNG SP**, **MAN/AUTO**, and **RAMP/SOAK** keys on the keypad. If the keys are disabled, pressing them has no effect. If you want to use these functions, turn off the keyboard lock.



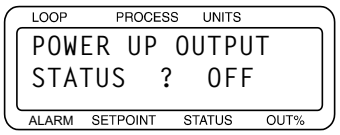
Selectable values: ON or OFF.

Power Up Output Status

WARNING! ***Do not set the controller to start from memory if it may be unsafe for your process to have outputs on upon power-up.***

Set the initial power-up state of the control outputs. If you choose OFF, all loops are initially set to manual mode at 0% output. If you choose MEMORY, the loops are restored to the control status and output value prior to powering down.

See *In Case of a Power Failure on page 152* for information about how this feature affects ramp/soak profiles.

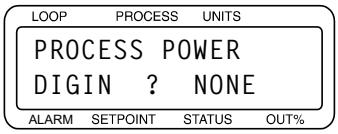


Selectable values: OFF or MEMORY.

Process Power Digital Input

To enable the thermocouple short detection feature, select a digital input (1 to 8). Connect the specified input to a device that pulls the input low when the process power is on. A short is indicated when the process power is on and the temperature does not rise as expected.

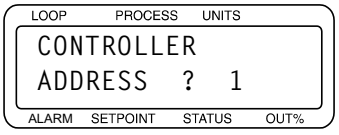
If the controller determines that there is a thermocouple short, it sets the loop to manual mode at the power level set for the SENSOR FAIL HT OUTPUT or SENSOR FAIL CL OUTPUT parameter in the SETUP LOOP OUTPUTS menu.



Selectable values: 1 to 8, or NONE.

Controller Address

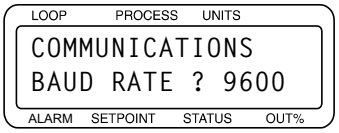
Set the communications address for the controller. On an EIA/TIA-485 communication loop, each controller must have a unique address. Begin with address 1 for the first controller and assign each subsequent controller the next higher address.



Selectable values: 1 to 247. When using one controller with Anasoft, select address 1. When using multiple controllers with Anasoft, use consecutive addresses from 1 to 16 only.

Communications Baud Rate

Set the communications baud rate.

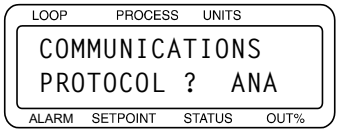


Selectable values: 9600, 2400 or 19200.

NOTE! ***Set the baud rate to the same speed in both the controller and the HMI software or panel.***

Communications Protocol

Set the communications protocol. Choose the correct protocol for the software or device with which the controller will communicate. You must switch power to the controller off, then back on, to make a change to this parameter take effect.

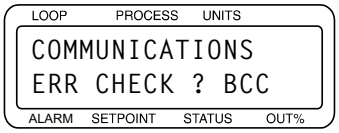


Selectable values: MOD (Modbus RTU), ANA (Anafaze), AB (Allen Bradley).

Communications Error Checking

If you selected the ANA or AB communications protocol, set the data check algorithm for CLS200 communications.

CRC (Cyclic Redundancy Check) is a more secure error checking algorithm than BCC, but it requires more calculation time and slows communications. BCC (Block Check Character) ensures a high degree of communications integrity. We recommend BCC unless your application requires CRC.



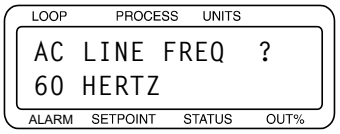
Selectable values: BCC or CRC.

NOTE! ***If you are using Anasoft, configure it with ANAINSTL for the same error checking method and baud rate set in the controller.***

AC Line Frequency

Specify the ac line frequency. Since the controller reduces the effect of power line noise on the analog measurement by integrating the signal over the period of the ac line frequency, the controller must know the frequency of power in use.

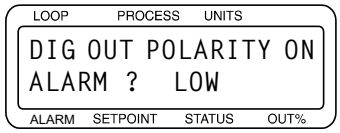
You must switch power to the controller off, then back on, to make a change to this parameter take effect.



Selectable values: 50 or 60 Hz.

Digital Output Polarity on Alarm

Set the polarity of all digital outputs used for alarms. If LOW is selected, if an alarm occurs the outputs sink to analog common. If HIGH is selected, the outputs sink to common when no alarm is active and go high when an alarm occurs.



Selectable values: HIGH or LOW.

This parameter does not affect the Global Alarm output or the Watchdog Alarm output.

EPROM Information

The display shows the controller type, firmware options, the firmware version and the EPROM checksum. *Table 4.4* lists the available firmware options.

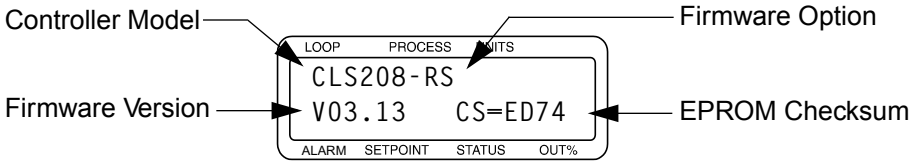
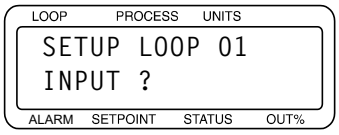


Table 4.4 Firmware Option Codes

Firmware Option	Description
(none)	Standard Firmware
-EF	Enhanced Features Option
-RS	Ramp/Soak Option
-EX	Extruder Option

NOTE! ***If the EPROM information does not match this description, the EPROM probably contains a custom program. Custom programs may not work as described in this manual. If that is the case, contact your dealer for more information about the firmware.***

Setup Loop Input Menu



The SETUP LOOP INPUT menu includes parameters related to the loop input:

- Input type
- Input units
- Input scaling and calibration
- Input filtering

Table 4.5 Setup Loop Input

Parameter	Default Value
INPUT TYPE?	J
LOOP NAME?	01
INPUT UNITS?	°F
INPUT READING OFFSET?	0° F
REVERSED T/C DETECT?[3]	OFF
INPUT PULSE SAMPLE TIME?[1]	1
DISP FORMAT?[2]	-999 TO 3000
INPUT SCALING HI PV?[2]	1000
INPUT SCALING HI RDG?[2]	100.0% FS
INPUT SCALING LO PV?[2]	0
INPUT SCALING LO RDG?[2]	0.0% FS
INPUT FILTER?	3 SCANS

[1] This parameter is available only for the pulse loop (loop 5 on CLS204, loop 9 on CLS208, loop 17 on CLS216).

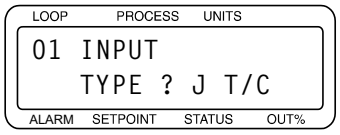
[2] These parameters are available only if LINEAR is selected for INPUT TYPE.

[3] These parameter is available only if INPUT TYPE is set to one of the thermocouple or RTD options.

Input Type

Specify the type of input sensor used on this loop:

- Thermocouple type J, K, T, S, R, B or E.
- RTD 1 or RTD 2.
- Linear input.
- Skip (an input type available for unused loops). Alarms are not detected, and the scanning display does not show loops that are set to SKIP.
- Pulse input (available only for loop 5 on CLS204, loop 9 on CLS208 or loop 17 on CLS216).



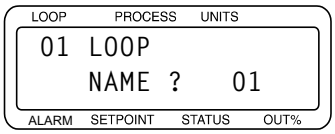
Selectable values: See *Table 4.6*.

Table 4.6 CLS200 Input Types and Ranges

Input Type	Input Range
J T/C	-350 to +1,400° F (-212 to +760° C)
K T/C	-450 to +2,500° F (-268 to +1,371° C)
T T/C	-450 to +750° F (-268 to +399° C)
S T/C	0 to +3,200° F (-18 to +1,760° C)
R T/C	0 to +3,210° F (-18 to +1,766° C)
B T/C	+150 to 3,200° F (+66 to 1,760° C)
E T/C	+150 to 3,200° F (+66 to 1,760° C)
RTD1	-148.0 to +572.0° F (-100.0 to +275.0° C)
RTD2	-184 to +1,544° F (-120 to +840° C)
PULSE	0 to 2 kHz
SKIP	Loop not used.
LINEAR	See *Linear Scaling Parameters on page 86*.

Loop Name

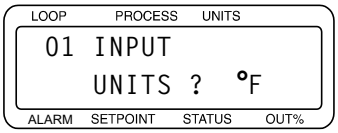
Assign a two-character name to the loop. This name is shown on the single loop display in place of the loop number.



Selectable values: 0 to 9, A to Z, %, /, ° (degree symbol).

Input Units

For loops with temperature sensor input types, choose a temperature scale: Fahrenheit or Celsius. For a linear or pulse loop, choose a three-character description of the loop's engineering units.



Selectable values: The table below shows the character set for input units.

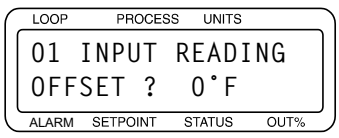
Table 4.7 Input Character Sets

Input	Character Sets for Units
Thermocouple or RTD	°F or °C
Linear or Pulse	0 to 9, A to Z,%, /, °, space

Input Reading Offset

If the input type is a thermocouple or RTD, specify the offset to correct for signal inaccuracy at a given point. For example, at temperatures below 400° F, a type J thermocouple may be inaccurate or "offset" by several degrees. Use an independent thermocouple or your own calibration equipment to find the offset for your equipment.

A positive value increases the reading and a negative value decreases it.



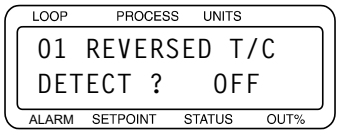
Selectable values: See *Table 4.8*.

Table 4.8 Input Reading Offset

Type of Sensor	Offset Range	
	°F	°C
RTD2 J K T	-300 to +300	-300 to +300
RTD1	-300.0 to +300.0	-300.0 to +300.0
B S	-300 to +76	-300 to +300
R	-300 to +66	-300 to +300

Reversed T/C Detection

Set this parameter to ON to enable polarity checking for thermocouples. If a reversed thermocouple is detected, the controller sets the loop to manual control at the SENSOR FAIL HT OUTPUT or SENSOR FAIL CL OUTPUT power level and displays the alarm.

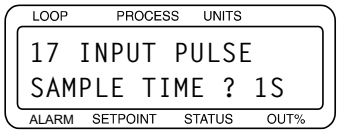


Selectable values: ON or OFF.

Input Pulse Sample Time

You can connect a digital pulse signal of up to 2 kHz to the pulse input. Use this parameter to set the time over which pulses are counted. The controller counts pulses for the amount of time you set here before calculating the frequncy. The controller scales this frequency and uses the resulting value as the process variable for the pulse loop. Generally, the longer the pulse sample time, the more stable the process variable, but the slower the response of the pulse loop.

This parameter is available only for loop 5 on the CLS204, loop 9 on the CLS208 or loop 17 on the CLS216.



Selectable values: 1 to 20 seconds.

Linear Scaling Parameters

The following parameters are only available if the input type is LINEAR or PULSE. These parameters let you scale the raw input readings (in millivolts or Hertz) to the engineering units of the process variable.

For linear inputs, the input reading is in percent (0 to 100%) representing the 0 to 60mV input range of the controller. For pulse inputs, the input reading is in Hertz (cycles per second.)

The scaling function is defined by two points on a conversion line. This line relates the process variable (PV) to the input signal. The engineering units of the process variable can be any units—the graph in *Figure 4.2* shows PSI as an example.

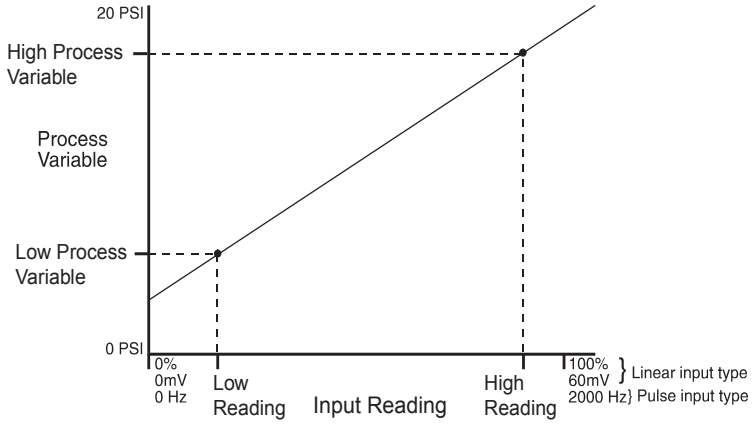


Figure 4.2 Two Points Determine Process Variable Conversion

Before you enter the values determining the two points for the conversion line, you must choose an appropriate display format. The controller has six characters available for process display; select the setting with the desired number of decimal places. Use a display format that matches the range of the process variable and resolution of the sensor. The display format you choose is used for the process variable setpoint, alarms limits, deadband, spread and proportional band.

The process variable range for the scaled input is between the process variable values that correspond to the 0% and 100% input readings. For the pulse input, it is between the 0 Hz and 2000 Hz readings. The process variable range defines the limits for the setpoint and alarms. See *Figure 4.3*.

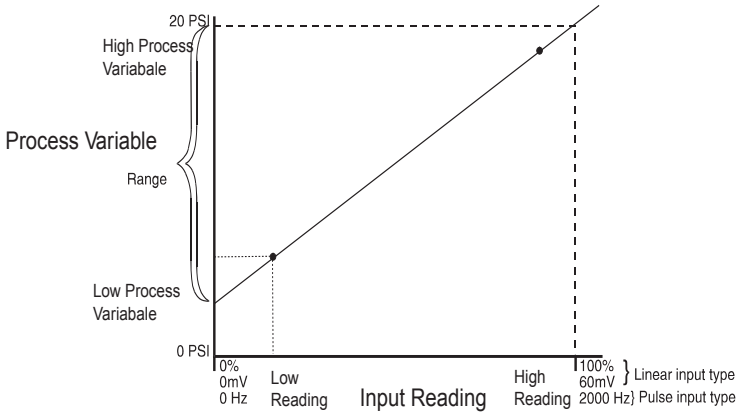
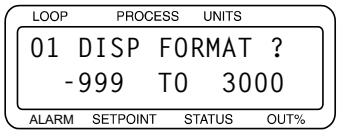


Figure 4.3 Process Variable Limited by Input Reading Range

Display Format

Select a display format for a linear or pulse input. Choose a format appropriate for the input range and sensor accuracy.



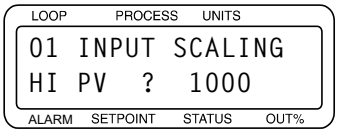
Selectable values: The controller has several available display formats, as shown in *Table 4.9*. The table also shows the maximum and minimum process variable for each display format.

Table 4.9 Display Formats

Display Format	Maximum Process Variable	Minimum Process Variable
-9999 TO +30000	30,000	-9,999
-999 TO +3000	3,000	-999
-999.9 TO +3000.0	3,000.0	-999.9
-99.99 TO +300.00	300.00	-99.99
-9.999 TO +30.000	30.000	-9.999
-.9999 TO +3.0000	3.0000	-0.9999

High Process Variable

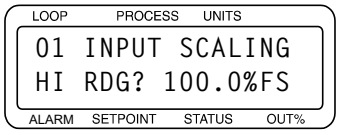
Set a high process variable for input scaling purposes. The high process variable and the high reading (HI RDG) together define one of the points on the linear scaling function's conversion line. Set HI PV to the value you want displayed when the signal is at the level set for the high reading (HI RDG).



Selectable values: Any value between the low process variable (LO PV) and the maximum process variable for the selected display format. See *Table 4.9*.

High Reading

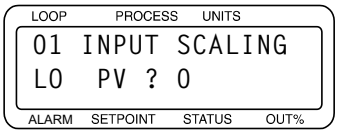
Enter the input signal level that corresponds to the high process variable (HI PV) you entered in the previous parameter.



Selectable values: For linear inputs, any value between -99.9% and 999.9% of full scale, where 100% corresponds to 60mV and 0% corresponds to 0mV. For pulse inputs, any value between 0 and 2000 HZ. The high reading must be greater than the low reading (LO RDG).

Low Process Variable

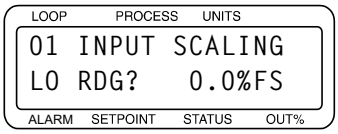
Set a low process variable for input scaling purposes. The low process variable and the low reading (LO RDG) together define one of the points on the linear scaling function's conversion line. Set LO PV to the value you want displayed when the signal is at the level set for the low reading (LO RDG).



Selectable values: Any value between the minimum process variable and the high process variable for the selected display format. See *Table 4.9 on page 87*.

Low Reading

Enter the input signal level that corresponds to the low process variable (LO PV) you entered in the previous parameter.

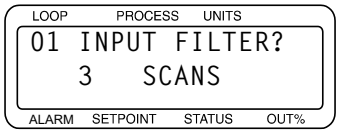


Selectable values: For linear inputs, any value between -99.9% and 999.9% percent of full scale, where 100% corresponds to 60mV and 0% corresponds to 0mV. For pulse inputs, any value between 0 and 2000 HZ. The low reading must be less than the high reading (HI RDG).

Input Filter

The controller has two types of input filtering:

- The rejection filter ignores sensor readings outside the acceptance band when subsequent readings are within the band. For temperature sensors, the band is ±5° about the last accepted reading. For linear inputs the band is ±0.5% of the input range. This filter is not adjustable.
- A simulated resistor-capacitor (RC) filter damps the input response if inputs change unrealistically or change faster than the system can respond. If the input filter is enabled, the process variable responds to a step change by going to 2/3 of the actual value within the number of scans you set.



Selectable values: 0 to 255 scans. 0 disables the filter.

Setup Loop Control Parameters Menu

Use the SETUP LOOP CONTROL PARAMS menu to adjust heat and cool control parameters, including:

- Proportional band (PB, or gain), integral (TI or reset), and derivative (TD, or rate) settings
- Output filter
- Spread between heat and cool outputs

The controller has separate PID and filter settings for heat and cool outputs. The screens used to set these parameters are nearly identical. In this section, only the heat screens are shown and explained. The heat and cool parameters appear only if the corresponding output is enabled.

See *Setup Loop Outputs Menu on page 93* for help enabling and disabling heat and cool outputs.

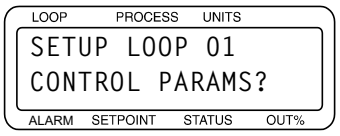


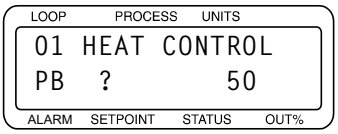
Table 4.10 shows the parameters available in the SETUP LOOP CONTROL PARAMS menu.

Table 4.10 Setup Loop Control Parameters

Parameter	Default Value
HEAT CONTROL PB?	Depends upon the INPUT TYPE setting; 50 for J-type thermocouple.
HEAT CONTROL TI?	Depends upon the INPUT TYPE setting; 180 SEC/R for J-type thermocouple.
HEAT CONTROL TD?	0
HEAT CONTROL FILTER?	3
COOL CONTROL PB	50
COOL CONTROL TI?	Depends upon the INPUT TYPE setting; 60 SEC/R for J-type thermocouple.
COOL CONTROL TD?	Depends upon the INPUT TYPE setting; 0 SECONDS for J-type thermocouple.
COOL CONTROL FILTER?	3
SPREAD?	5
RESTORE PID DIGIN?	NONE

Heat or Cool Control PB

Set the proportional band (also known as gain). A larger value yields less proportional action for a given deviation from setpoint.



Selectable values: Dependent upon sensor type.

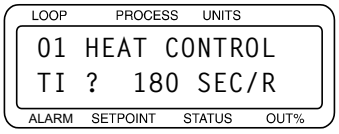
The controller internally represents the proportional band (PB) as a gain value. When you edit the proportional band, you will see the values change in predefined steps; small steps for narrow proportional band values and large steps for wide proportional band values.

The controller calculates the default proportional band for each input type according to the following equation:

$$\text{Default PB} = \frac{(\text{High Range} - \text{Low Range})}{\text{Gain}}$$

Heat or Cool Control TI

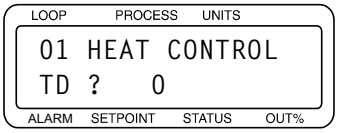
Set the integral term (also known as reset). A larger value yields less integral action.



Selectable values: 0 (off) to 6000 seconds.

Heat or Cool Control TD

Set the derivative constant. A larger value yields greater derivative action.

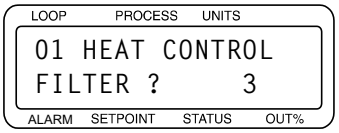


Selectable values: 0 to 255 seconds.

Heat or Cool Output Filter

Dampen the response of the heat or cool output. The output responds to a step change by going to approximately 2/3 of its final value within the number of scans you set here. A

larger value results in a slower, or more dampened, response to changes in the process variable.



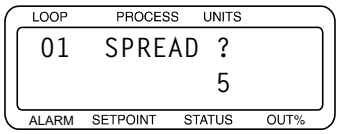
Selectable values: 0 to 255. 0 disables the output filter.

Spread

For a loop using on/off control, the spread is the control hysteresis. This determines the difference between the point at which a heat output turns off as the temperature rises, and the point at which it turns back on as the temperature falls.

For a loop using PID control, the spread determines how far the process variable must be from the setpoint before the controller can switch from heating to cooling. A loop will not switch from heat to cool or vice versa unless the process variable deviates from setpoint by more than the spread.

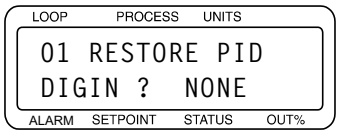
When the loop is using PID control and the spread is set to 0, the PID calculation alone determines when the heat or cool output should be on.



Selectable values: 0 to 255, 25.5, 2.55, .255, or .0255, depending upon the DISP FORMAT setting.

Restore PID Digital Input

To enable the sensor failure recovery feature, select a digital input at this parameter. If the specified input is held low when the sensor fails, the loop returns to automatic control after a failed sensor is corrected.



Selectable range: NONE (disable the sensor failure recovery feature), 1 to 8.

Setup Loop Outputs Menu

Use the SETUP LOOP OUTPUTS menu to:

- Enable or disable outputs
- Set output type
- Set cycle time for time proportioning outputs
- Enter Serial DAC parameters (for Serial DAC outputs)
- Select control action
- Set output level limit and limit time
- Select sensor fail output (output override)
- Select a nonlinear output curve

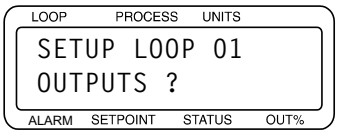


Table 4.11 shows the parameters available in the SETUP LOOP OUTPUTS menu. Both heat and cool outputs have the same parameters; only one of each parameter is shown.

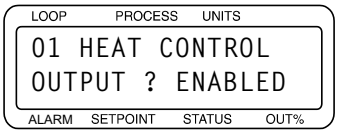
Table 4.11 Setup Loop Outputs

Parameter	Default Value
HEAT CONTROL OUTPUT?	ENABLED
HEAT OUTPUT TYPE?	TP
HEAT OUTPUT CYCLE TIME?	10S
SDAC MODE?*	VOLTAGE
SDAC LO VALUE?*	0.00 VDC
SDAC HI VALUE?*	10.00 VDC
HEAT OUTPUT ACTION?	REVERSE
HEAT OUTPUT LIMIT?	100%
HEAT OUTPUT LIMIT TIME?	CONT
SENSOR FAIL HT OUTPUT?	0%
HEAT T/C BRK OUT AVG?	OFF
HEAT OUTPUT?	LINEAR
COOL CONTROL OUTPUT?	DISABLED

* The SDAC parameters are available only if you select SDAC as the output type. Use these parameters to configure the Serial DAC signal output.

Enable or Disable Heat or Cool Outputs

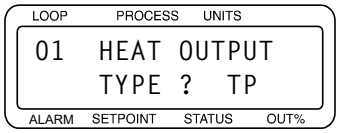
Enable or disable the heat or cool output for the loop. If you want the loop to have a control output, you must enable at least one output. You can also disable a heat or cool control output and use the output for something else, such as an alarm.



Selectable values: ENABLED or DISABLED.

Heat or Cool Output Type

Select the output type.



Selectable values: TP, DZC, SDAC, ON/OFF, 3P DZC. See *Table 4.12* for a description of the output types.

NOTE! ***The controller assigns digital output 34 as a clock line for the Serial DAC. You will not be able to assign another function to output 34 if any loop's output is set to SDAC.***

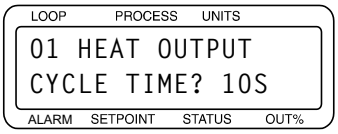
Table 4.12 Heat / Cool Output Types

Display Code	Output Type	Definition
TP	Time Proportioning	Percent output converted to a percent duty cycle over the user-selected, fi ed time base.
DZC	Distributed Zero Crossing	Output on/off state calculated for every ac line cycle. Use with Dual DAC.
SDAC	Serial DAC	Use with Serial DAC.
ON/OFF	On/Off	Output either full on or full off.
3P DZC	3-Phase Distributed Zero Crossing	Use with 3-phase heaters when wired in delta configu ation. (For grounded Y configu ation, use DZC instead.)

For an expanded description of these output types, see *Chapter 8, Tuning and Control.*

Heat or Cool Cycle Time

Set the cycle time for time proportioning outputs.

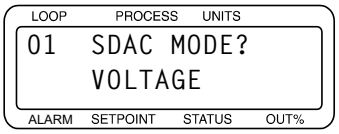


This parameter appears only if the heat or cool output type for the loop is set to time proportioning (TP).

Selectable values: 1 to 255 seconds.

SDAC Mode

Select the Serial DAC output signal.

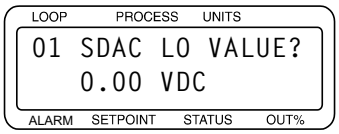


Selectable values: CURRENT or VOLTAGE.

SDAC Low Value

Set the low output signal level for the Serial DAC. The Serial DAC converts 0% output from the controller to the value set here.

Set the high and low values to match the input range of the output device. For instance, if the output device has a 0.00-10.00 V range, set the SDAC LO VALUE to 0.00 VDC and set the SDAC HI VALUE to 10.00 VDC.



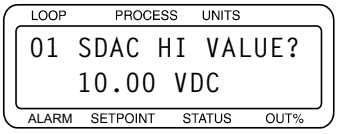
Selectable values: 0.00 to 9.00 VDC or 0.0 to 19.90 MA. This value must be less than the SDAC HI VALUE.

SDAC High Value

Set the high output signal level for the Serial DAC. The Serial DAC converts 100% output from the controller to the value set here.

Set the high and low values to match the range of the output device. For instance, if the output device has a 4 to 20

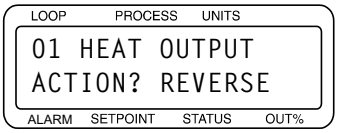
mA range, set the SDAC HI VALUE to 20.00 MA and the SDAC LO VALUE to 4.00 MA.



Selectable values: 0.10 to 10.00 VDC or 0.10 to 20.00 mA. This value must be greater than the SDAC LO VALUE.

Heat or Cool Output Action

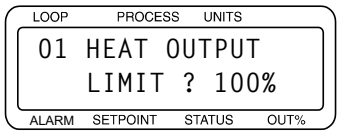
Select the control action for the output. Normally, heat outputs are set to reverse action and cool outputs are set to direct action. When output action is set to REVERSE, the output goes up when the process variable goes down. When set to DIRECT, the output goes up when the process variable goes up.



Selectable values: REVERSE or DIRECT.

Heat or Cool Output Limit

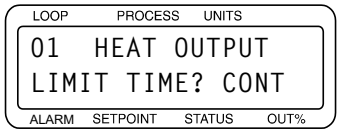
This parameter limits the maximum PID control output for a loop's heat or cool output. This limit may be continuous, or it or it may be in effect for a specified number of seconds (see the next parameter). If you choose a timed limit, the output limit time restarts when the controller powers up and whenever the loop goes from manual to automatic control. The output limit only affects loops under automatic control. It does not affect loops under manual control.



Selectable values: 0 to 100%.

Heat or Cool Output Limit Time

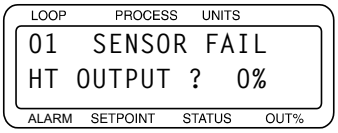
Set a time limit for the output limit set at the previous parameter.



Selectable values: 1 to 999 seconds, or to CONT (continuous).

Sensor Fail Heat or Cool Output

When a sensor fail alarm occurs or when the OUTPUT OVERRIDE DIG INPUT (*page 77*) becomes active on a loop that is in automatic control, that loop goes to manual control at the percent power output set here.



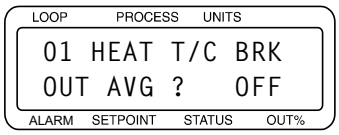
Selectable values: 0 to 100%.

NOTE! ***When a sensor fails or the override input is detected, both the heat and cool outputs are set to their fail settings. In most applications, SENSOR FAIL HT OUTPUT and SENSOR FAIL CL OUTPUT should be set to 0%.***

WARNING! ***Do not rely solely on the sensor fail alarm to adjust the output in the event of a sensor failure. If the loop is in manual control when a failed sensor alarm occurs, the output is not adjusted. Install independent external safety devices that will shut down the system if a failure occurs.***

Heat or Cool Thermocouple Break Output Average

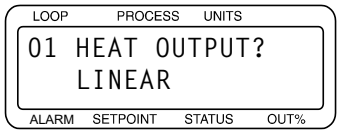
If you set this parameter to ON and a thermocouple break occurs, a loop set to automatic control status will go to manual mode at a percentage equal to the average output prior to the break.



Selectable range: ON or OFF

Heat or Cool Linearity

Select an output curve. For a nonlinear process, select CURVE 1 or CURVE 2.



Selectable values: CURVE 1, CURVE 2, or LINEAR. Refer to *Figure 4.4*.

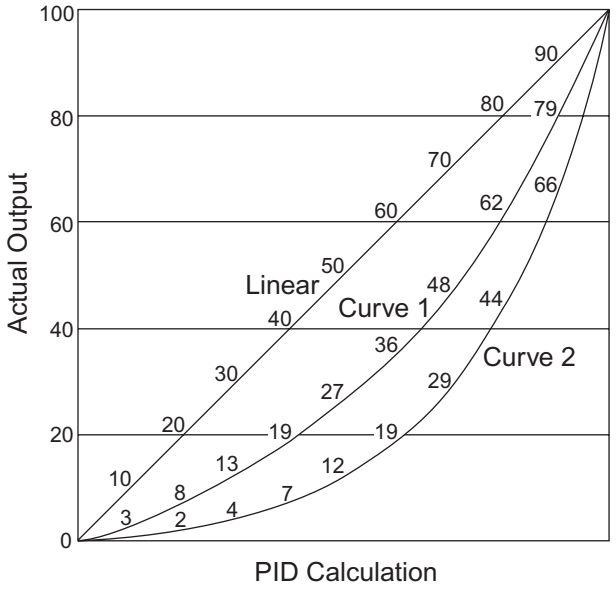


Figure 4.4 Linear and Nonlinear Outputs

If curve 1 or 2 is selected, a PID calculation results in a lower actual output level than the linear output requires. One of the nonlinear curves may be used when the response of the system to the output device is nonlinear.

Setup Loop Alarms Menu

Use the SETUP LOOP ALARMS menu to set:

- High and low process and deviation alarm limits
- Alarm outputs
- Alarm/control behavior
- Alarm deadband
- Alarm delay

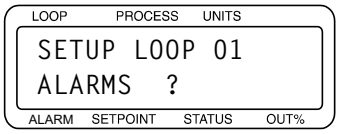


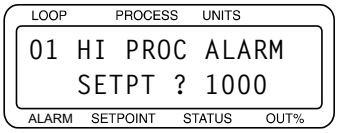
Table 4.13 shows the parameters available in the SETUP LOOP ALARMS menu.

Table 4.13 Setup Loop Alarms

Parameter	Default Value
HI PROC ALARM SETPT?	1000
HI PROC ALARM TYPE?	OFF
HI PROC ALARM OUTPUT?	NONE
DEV ALARM VALUE?	5
HI DEV ALARM TYPE?	OFF
HI DEV ALARM OUTPUT?	NONE
LO DEV ALARM TYPE?	OFF
LO DEV ALARM OUTPUT?	NONE
LO PROC ALARM SETPT?	0
LO PROC ALARM TYPE?	OFF
LO PROC ALARM OUTPUT?	NONE
ALARM DEADBAND?	2
ALARM DELAY?	0 SECONDS

High Process Alarm Setpoint

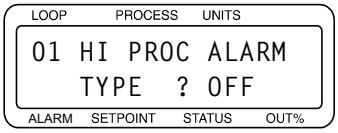
Set the value at which the high process alarm activates.



Selectable values: Any point within the scaled sensor range.

High Process Alarm Type

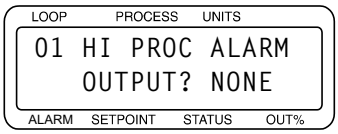
Select an alarm type for the high process alarm.



Selectable values: OFF, ALARM, or CONTROL.

High Process Alarm Output Number

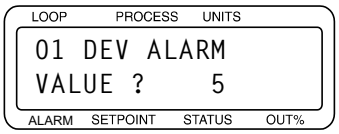
Choose a digital output to activate when the high process alarm occurs, if desired.



Selectable values: NONE, or any output from 1 to 34 not enabled for closed-loop control or for the Serial DAC clock.

Deviation Alarm Value

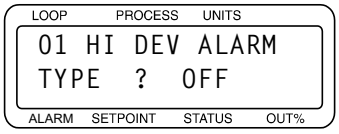
Set the deviation from setpoint at which the high and low deviation alarms occur.



Selectable values: 0 to 255, 25.5, 2.55, .255 or .0255, depending on the INPUT TYPE and DISP FORMAT settings.

High Deviation Alarm Type

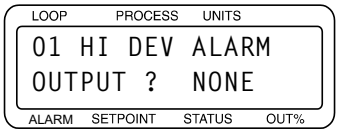
Select an alarm type for the high deviation alarm.



Selectable values: ALARM, CONTROL or OFF

High Deviation Alarm Output Number

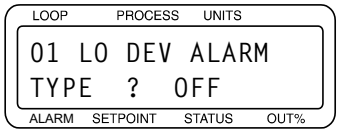
Choose a digital output to activate when the high deviation alarm occurs, if desired.



Selectable values: NONE, or any output from 1 to 34 not enabled for closed-loop control or for the Serial DAC clock.

Low Deviation Alarm Type

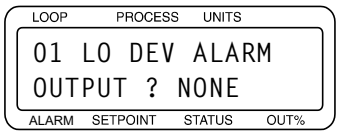
Select an alarm type for the low deviation alarm.



Selectable values: ALARM, CONTROL or OFF.

Low Deviation Alarm Output Number

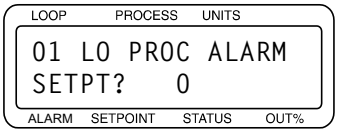
Choose a digital output to activate when the low deviation alarm occurs, if desired.



Selectable values: NONE, or any output from 1 to 34 not enabled for closed-loop control or for the Serial DAC clock.

Low Process Alarm Setpoint

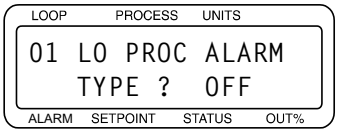
Set a low process alarm setpoint. See *Process Alarms on page 66.*



Selectable values: Any value within the input sensor's range.

Low Process Alarm Type

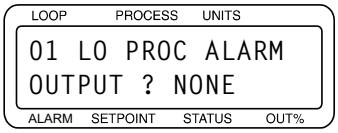
Select an alarm type for the low process alarm.



Selectable values: ALARM, CONTROL or OFF.

Low Process Alarm Output Number

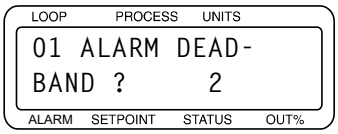
Choose a digital output to activate when the low process alarm occurs, if desired.



Selectable values: NONE, or any output from 1 to 34 not enabled for closed-loop control or for the Serial DAC clock.

Alarm Deadband

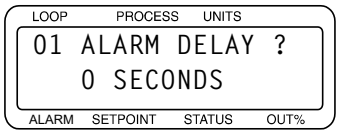
Set an alarm deadband. This deadband value applies to the high process, low process, high deviation and low deviation alarms for the loop. Use the alarm deadband to avoid repeated alarms as the process variable cycles around an alarm value.



Selectable values: 0 to 255, 25.5, 2.55, .255 or .0255, depending on the INPUT TYPE and DISP FORMAT settings.

Alarm Delay

Set a loop alarm delay. This parameter delays failed sensor and process alarms until the alarm condition has been continuously present for longer than the alarm delay time.



Selectable range: 0 to 255 seconds.

Manual I/O Test

This menu facilitates testing of:

- Digital inputs
- Digital outputs
- The keypad buttons

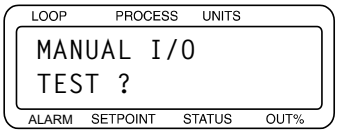


Table 4.14 shows the screens available in the MANUAL I/O TEST menu.

Table 4.14 Manual I/O Test

Parameter	Default Value
DIGITAL INPUTS	HHHHHHHH
TEST DIGITAL OUTPUT?	1: IN USE
DIGITAL OUTPUT NUMBER XX?	OFF
KEYPAD TEST	N/A

NOTE! ***The DIGITAL OUTPUT NUMBER screen appears only if an unassigned output has been selected in the TEST DIGITAL OUTPUT screen.***

Digital Inputs

View the logic state of the eight digital inputs as H (high) meaning the input is not pulled low, or L (low) meaning the input is connected to the controller common.

This screen shows the state of inputs 1 to 8 from left to right. See *Figure 4.5*. Since inputs are pulled high when they are not connected, test an input by shorting it to controller common and making sure this screen shows the correct state for that input.

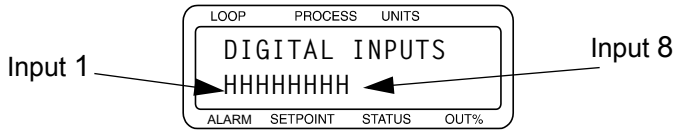


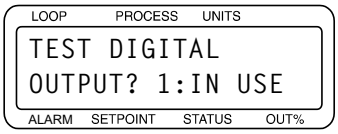
Figure 4.5 Digital Inputs Screen

When you are done testing digital inputs, press **YES** or **NO** to advance to the next screen, or press **BACK** to return to the MANUAL I/O TEST menu.

Test Digital Output

Select one of the digital alarm outputs to test. You will test the output on the next screen.

You cannot force the state of an output enabled for control.



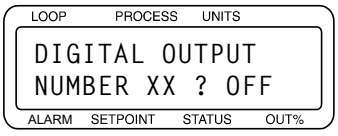
Selectable values: Any output from 1 to 34 that is not enabled for closed-loop control or for the Serial DAC clock and GA, the global alarm output.

Digital Output Number

This screen appears only if you selected an output that is not in use for control at the TEST DIGITAL OUTPUT screen.

Use this parameter to manually toggle a digital output on or off to test it. Toggling an output ON sinks current from the output to the controller common. Toggling the output OFF stops current flow. All tested outputs are set to OFF when you exit the MANUAL I/O TEST menu.

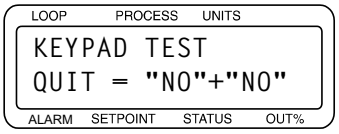
You cannot toggle outputs enabled for control. To test a control loop output, first disable it using the SETUP LOOP OUTPUTS menu.



Selectable values: ON or OFF.

Keypad Test

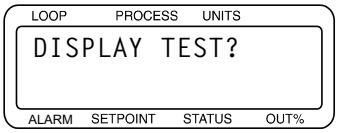
Test the keypad. The test begins automatically when the screen appears.



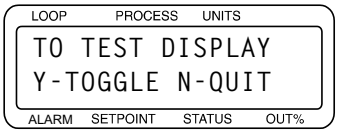
- Press any key to test the keypad. The controller will display the name of the key you have pressed.
- Press **NO** twice to end the test and return to the top of the MANUAL I/O TEST menu.

Display Test

Use this function to test the display.



Press **YES** to enter the test and display the instruction screen.



Press **YES** to begin the display of a discernable pixel pattern.

- Press **YES** to toggle the pixel pattern.
- Press **NO** to end the test and return to the top of the MANUAL I/O TEST menu.

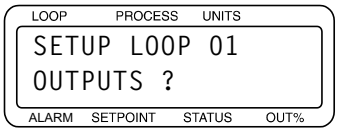
5

Extruder Control

This chapter explains the additional features for the CLS200 series controller equipped with Extruder Control Firmware. Except for setup, default and control algorithm differences described below, the Extruder Control Firmware operates the same as the standard control firmware.

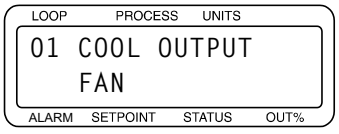
Setup Loop Outputs Menu

The SETUP LOOP OUTPUTS menu contains a parameter with descriptors for the selections that are different than those in the standard control firmware.



Cool Output Nonlinear Output Curve

Select linear or nonlinear output curves for the cool output.



Selectable Values: FAN, OIL or H2O. *See Figure 5.1.*

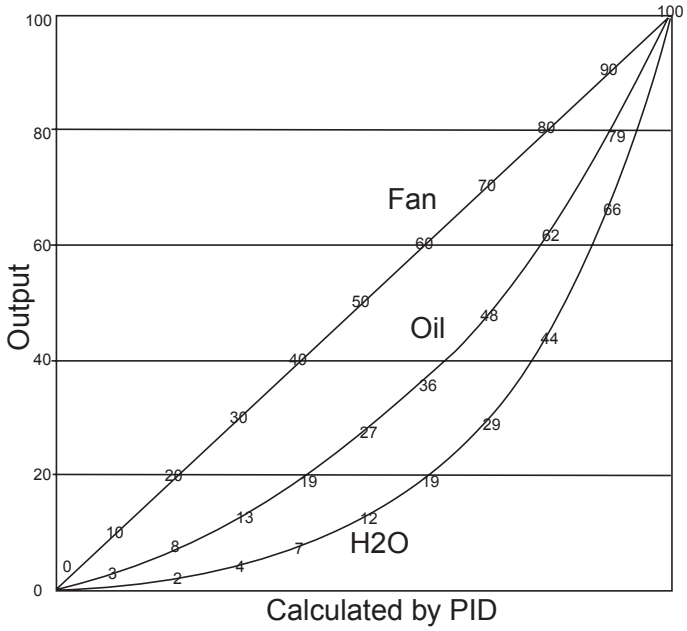


Figure 5.1 Cool Output Nonlinear Output Curve

The COOL OUTPUT parameter is located in the SETUP LOOP OUTPUTS menu. Select one of three nonlinear or linear output curves for cooling.

Defaults

The Extruder Control Firmware uses different defaults for some parameters in the SETUP LOOP CONTROL PARAMS menu. Furthermore, a unique set of control defaults are asserted whenever the COOL OUTPUT parameter on the SETUP LOOP OUTPUTS menu is changed. *Table 5.1* through *Table 5.3 on page 109* list the default parameter settings for each cool output curve.

NOTE! ***Changing the cool output curve parameter will change control parameter settings to defaults for that particular cool output curve.***

Table 5.1 Default Control Parameters for Fan Cool Output

Parameter	Default Value
HEAT CONTROL PB?	50 (for J-type thermocouple) depends on Input Type setting
HEAT CONTROL TI?	500 sec/repeat
HEAT CONTROL TD?	125 sec
HEAT CONTROL FILTER	6
COOL CONTROL PB?	10 (for J-type thermocouple) depends on Input Type setting
COOL CONTROL TI?	0 sec/repeat
COOL CONTROL TD?	0 sec
COOL CONTROL FILTER?	4

Table 5.2 Default Control Parameters for Oil Cool Output

Parameter	Default Value
HEAT CONTROL PB?	50 (for J-type thermocouple) depends on Input Type setting
HEAT CONTROL TI?	500 sec/repeat
HEAT CONTROL TD?	125 sec
HEAT CONTROL FILTER	6
COOL CONTROL PB?	35 (for J-type thermocouple) depends on Input Type setting
COOL CONTROL TI?	300 sec/repeat
COOL CONTROL TD?	60 sec
COOL CONTROL FILTER?	3

Table 5.3 Default Control Parameters for H2O Cool Output

Parameter	Default Value
HEAT CONTROL PB?	50 (for J-type thermocouple) depends on Input Type setting
HEAT CONTRO TI?	500 sec/repeat
HEAT CONTROL TD?	125 sec
HEAT CONTROL FILTER	6
COOL CONTROL PB?	70 (for J-type thermocouple) depends on Input Type setting
COOL CONTROL TI?	500 sec/repeat
COOL CONTROL TD?	90 sec
COOL CONTROL FILTER?	2

Extruder Control Algorithm

The Extruder Control Firmware uses a control algorithm that has been optimized for controlling temperature loops in plastic extruder equipment. Typically, overshoot is undesirable and ambient cooling is not sufficient to dampen the effects of self heating that are inherent in the extrusion process. This control method uses both heat and cool outputs. Under some conditions both heat and cool outputs may be on at the same time.

6

Enhanced Features

This chapter explains five additional features for the CLS200 controller when enabled with enhanced features option firmware:

- Process variable retransmit
- Cascade control
- Ratio control
- Remote analog setpoint
- Differential control

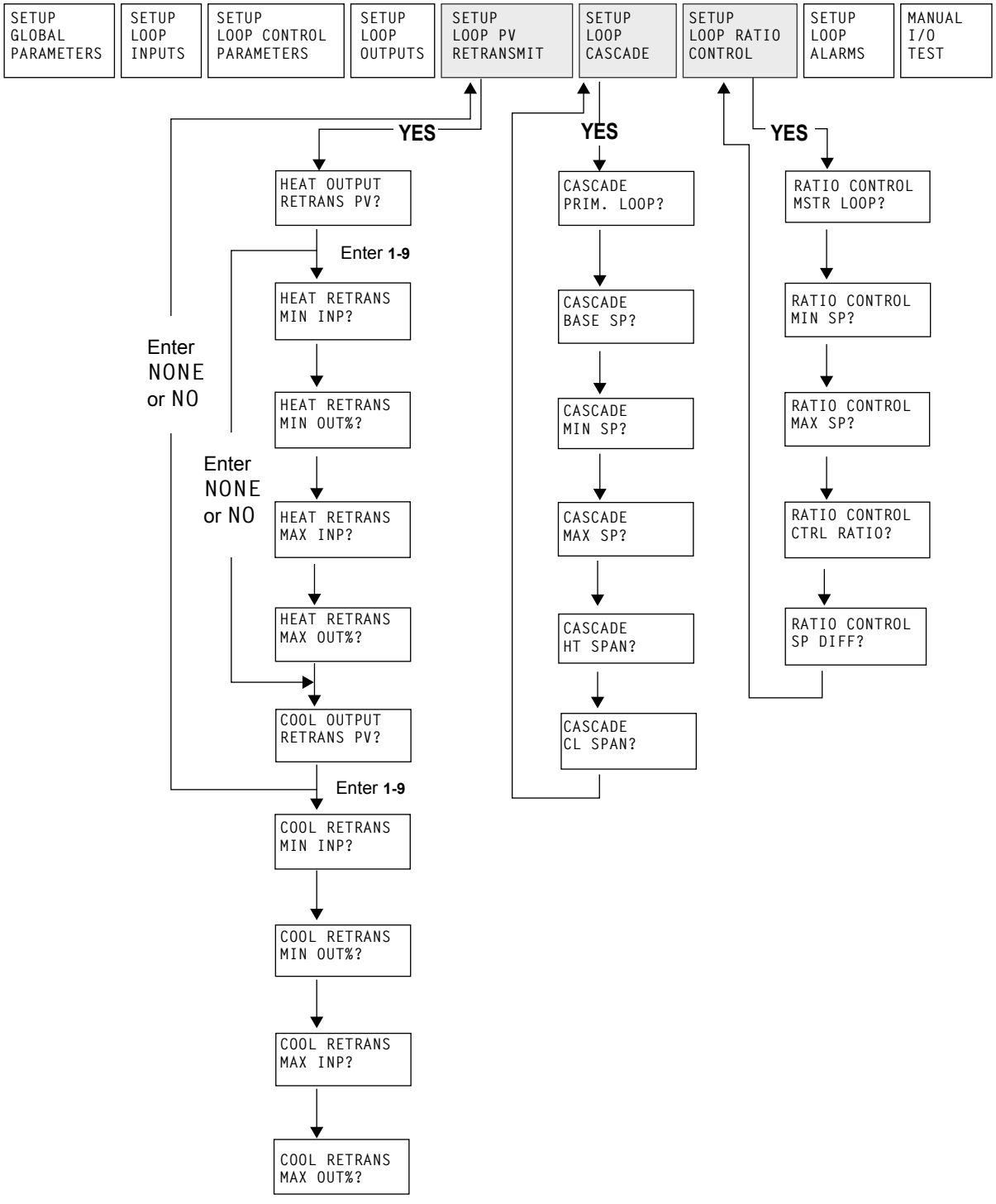


Figure 6.1 Enhanced Features Option Menus

Process Variable Retransmit

The process variable retransmit feature retransmits the process signal of one loop (primary) via the control output of another loop (secondary). This signal is linear and proportional to the engineering units of the primary loop input.

Typical uses include data logging to analog recording systems and long distance transmission of the primary signal to avoid degradation of the primary signal. The signal can also be used as an input to other types of control systems such as a PLC.

Any available output (heat or cool) may be used as a retransmit output. Any process variable (including the same loop number input) may be retransmitted.

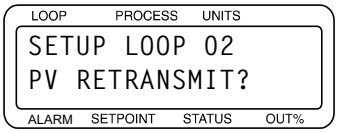
The controller output signal must be connected to a Dual DAC or Serial DAC converter to get a 4 to 20 mA⎓ (dc) or 0 to 5V⎓ (dc) signal. The choice of converter depends on application requirements.

The process variable retransmit feature is included in both the ramp/soak and enhanced features options.

NOTE! ***If an output is defined as a process variable retransmit, it cannot be used for PID control.***

Setup Loop Process Variable Retransmit Menu

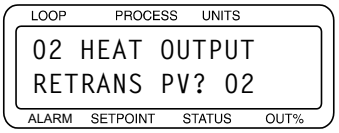
The setup parameters for the process variable retransmit feature appear in the SETUP LOOP PV RETRANSMIT menu.



Press **YES** to view the process variable retransmit parameters.

Retransmit Process Variable

Enter the number of the loop that provides the process variable for the retransmit calculation.

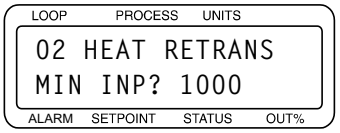


If you set this parameter NONE and press **NO**, the controller skips to the COOL OUTPUT RETRANS PV screen. The COOL parameter is set up the same way as the HEAT parameter.

Selectable values: Any loop or NONE.

Minimum Input

Enter the lowest value of the process variable to be retransmitted. This value is expressed in the same engineering units as the input loop.

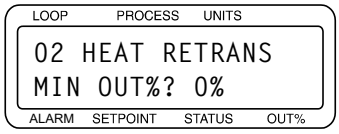


If the process variable falls below the minimum, the output will stay at the minimum value.

Selectable values: Any value in the input loop's range.

Minimum Output

Enter the output value (0 to 100%) that corresponds to the minimum input.

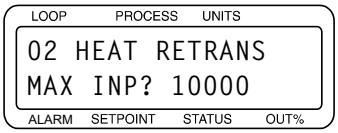


Selectable values: 0 to 100%

If you select a minimum output value other than 0%, the output will never drop below MIN OUT, even if the process variable drops below the MIN INP that you specified.

Maximum Input

Enter the highest value of the process variable to be retransmitted. This value is expressed in the same engineering units as the input loop.



If the process variable goes above the maximum, the output will stay at the maximum value.

Selectable values: Any value in the input loop's range.

By adjusting the maximum and minimum inputs, you can scale the output appropriately. See *Figure 6.2*.

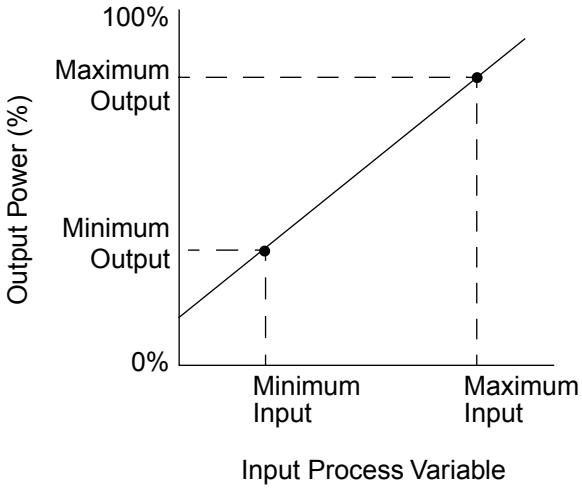
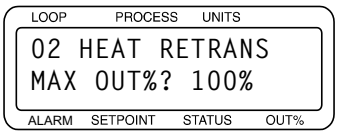


Figure 6.2 Linear Scaling of Process Variable for Retransmit

Maximum Output

Enter the output value (0 to 100%) which corresponds to the maximum input.



The output will never go above the this maximum output percentage, regardless of how high the process variable goes.

Selectable values: 0 to 100%

Process Variable Retransmit Example: Data Logging

The CLS200 controls the temperature of a furnace. The thermocouple in one of the zones is connected to the controller and is used for closed-loop PID control. An analog recorder data logging system is also in place, and a recording of the process temperature is required. The recorder input is a linear 4 to 20 mA⎓ (dc) signal representing a process variable range of 0 to 1000˚ F.

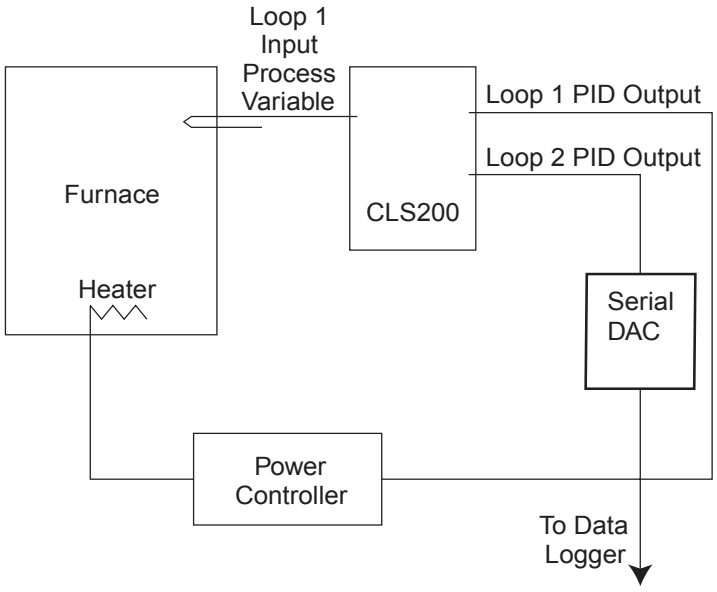
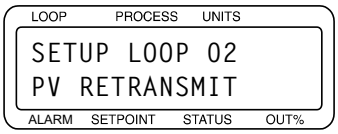
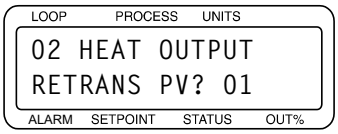
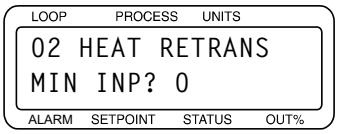
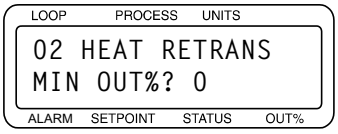
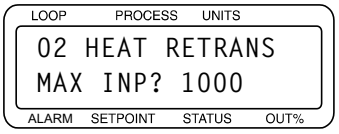
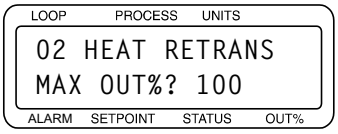
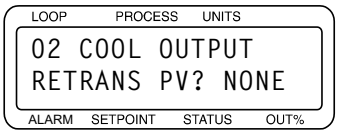


Figure 6.3 Application Using Process Variable Retransmit

To set up this application, you would do the following:

1. First, set up the standard control loop parameters according to the furnace application, in this case on loop 1.
2. Select another unused PID output for retransmitting the thermocouple value (for example, loop 2 heat output).
3. Change the display to loop 2, and then enter the three-key sequence (**ENTER**, then **ALARM ACK**, then **CHNG SP**) and go to the first screen in *Table 6.1*.
4. Follow the steps in *Table 6.1* to configure the process variable retransmit option.
5. After following the steps in *Table 6.1*, press **BACK** several times until the normal loop display appears. The controller will now produce an output on loop 2 which is linear and proportional to the loop 1 process variable.

Table 6.1 Application Example: Setting Up Process Variable Retransmit

Display	User Input
	Press **YES**.
	Enter 01 for loop 1 process variable. Press **ENTER**.
	Enter the minimum input value, which corresponds to the minimum output percentage. For a range of 0 to 1000° F, set the minimum input value to 0° F. Press **ENTER**.
	Enter the minimum output percentage, from 0 to 100%. For this example we will assume a full span with a minimum of 0%. Press **ENTER**.
	Enter the maximum input value, which corresponds to the maximum output percentage. For a range of 0 to 1000° F, set the maximum input value to 1000° F. Press **ENTER**.
	Enter the maximum output percentage, from 0 to 100%. For this example we will assume a full span with a maximum of 100%. Press **ENTER**.
	The process variable retransmit section of the controller programming is now completed. We are not using the cool output of loop 2 to retransmit a process variable, so choose NONE. Press **ENTER**.

Notes about this application:

- This is not a thermocouple curve type of signal and requires a linear input range in the recorder.
- To complete this configuration, the loop 2 output must be enabled and tailored to meet the requirements of the data-application. In this example, the data logger requires an analog input of 4 to 20 mA.
- The CLS200 Series controllers must be used with a Watlow Anafaze Serial DAC.

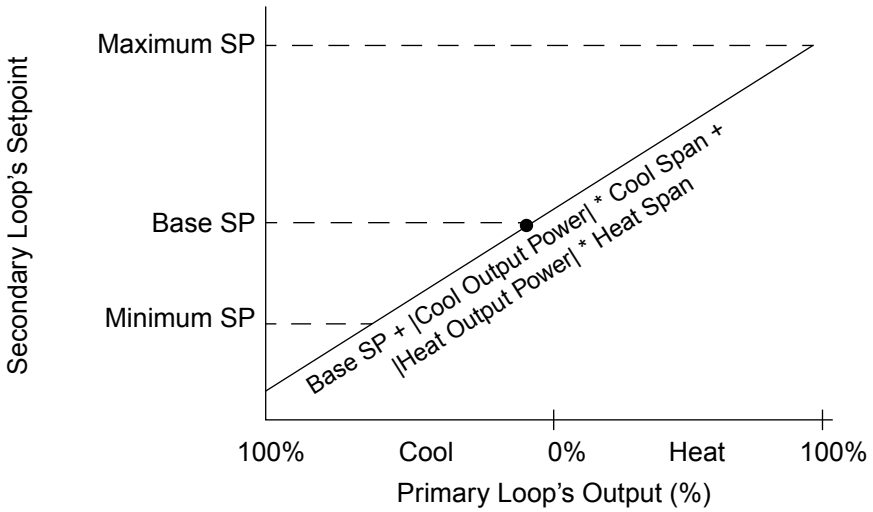
Consult *Chapter 4, Setup* for information on setting up the other options of the controller.

Cascade Control

Cascade control is used to control thermal systems with long lag times, which cannot be as accurately controlled with a single control loop. The output of the first (primary) loop is used to adjust the setpoint of the second (secondary) loop. The secondary loop normally executes the actual control.

The cascade control feature allows the output percentage of one control loop to determine the setpoint of a second control loop. By adjusting the setpoint (SP) parameters, the user can adjust the influence that the primary loop has on the setpoint of the secondary loop. See *Figure 6.4*.

Some applications, such as aluminum casting, use two-zone cascade control where the primary output is used for the primary heat control and the cascaded output is used for boost heat. The CLS200 allows you to use the primary heat output for both control and for determining the setpoint of the secondary loop.



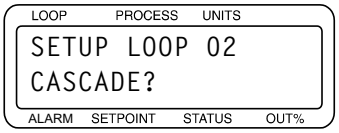
Calculation of new secondary loop setpoint:
SP2 = Base SP + |Cool Output Power| * Cool Span + |Heat Output Power| * Heat Span

Figure 6.4 Relationship Between the Primary Loop's Output and the Secondary Loop's Setpoint

NOTE! ***Cascade control cannot be used on the same control loop as ratio control. However, both features may be used in the same multiloop controller.***

Setup Loop Cascade Menu

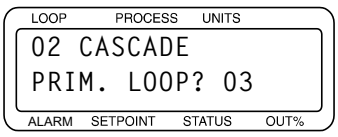
The setup parameters for cascade control appear under the SETUP LOOP CASCADE menu.



Press **YES** to set up the cascade parameters. The loop currently displayed (loop 02 in this case) will be the secondary control loop, which performs the actual control.

Primary Loop

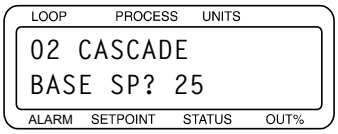
Enter the primary loop number. The output percentage of this loop will control the setpoint of the secondary loop.



Selectable values: Any loop except the secondary loop.

Base Setpoint

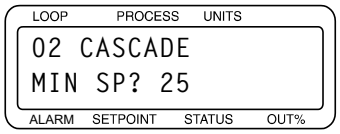
Enter the setpoint that corresponds to 0% (heat and cool) output from the primary loop (PRIM. LOOP). This value is expressed in the same engineering units as the secondary loop's process variable.



Selectable values: Any value from the secondary loop's minimum process variable to its maximum process variable.

Minimum Setpoint

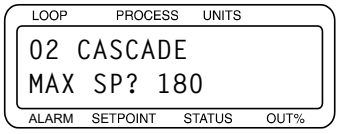
Enter the lowest value of the secondary loop setpoint. This minimum setpoint overrides any calculation caused by the primary loop calling for a lower setpoint. This value is expressed in the same engineering units as the secondary loop's process variable.



Selectable values: Any value from the secondary loop's minimum process variable to its maximum process variable.

Maximum Setpoint

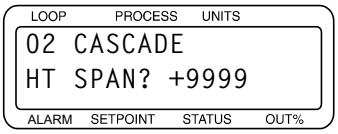
Enter the highest value of the secondary loop setpoint. This maximum setpoint overrides any calculation caused by the primary loop calling for a higher setpoint. This value is expressed in the same engineering units as the secondary loop's process variable.



Selectable values: Any value from the secondary loop's minimum process variable to its maximum process variable.

Heat Span

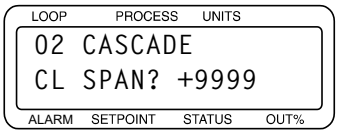
Enter the multiplier to apply to the primary loop heat output percentage.



Selectable values: -9999 to +9999.

Cool Span

Enter the multiplier to apply to the primary loop cool output percentage.



Selectable values: -9999 to +9999.

Cascade Control Example: Water Tank

A tank of water has an inner and outer thermocouple. The outer thermocouple is located in the center of the water. The inner thermocouple is located near the heating element. The desired temperature of the water is 150° F, which is measured at the outer thermocouple. Using cascade control, the outer thermocouple is used on the primary loop (in this example, loop 1), and the inner thermocouple is used on the secondary loop (loop 2). The heater is controlled by loop 2 with a setpoint range of 150 to 190° F.

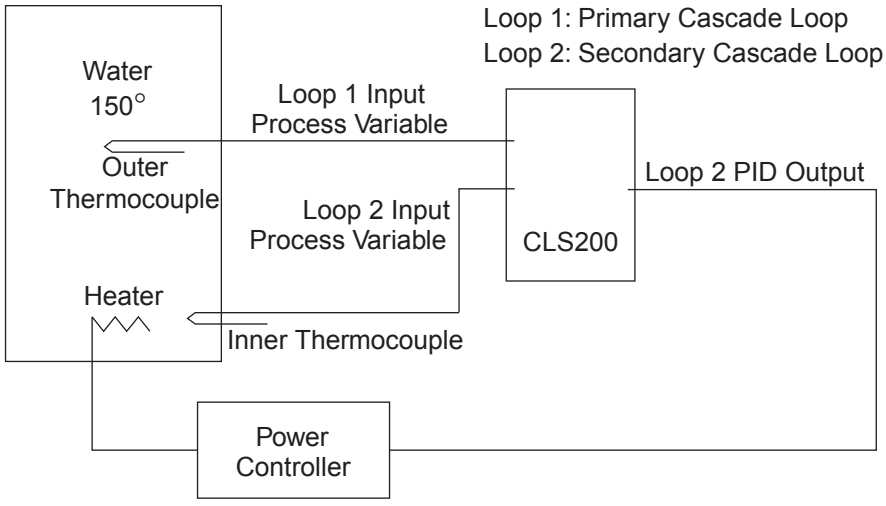


Figure 6.5 Application Using Cascade Control

To set up this application, you would do the following:

1. Change the display to loop 2, which will be the secondary loop, and then enter the three-key sequence (**ENTER**, then **ALARM ACK**, then **CHNG SP**) and go to the first screen in *Table 6.2*.
2. Follow the steps in *Table 6.2* to configure cascade control.

Table 6.2 Application Example: Setting Up Cascade Control

Display	User Input
LOOP PROCESS UNITS SETUP LOOP 02 CASCADE? ALARM SETPOINT STATUS OUT%	Press **YES** to set up the cascade parameters with loop 2 as the secondary loop.
LOOP PROCESS UNITS 02 CASCADE PRIM. LOOP? 01 ALARM SETPOINT STATUS OUT%	Enter 01 to make loop 1 the primary loop. Press **ENTER**.
LOOP PROCESS UNITS 02 CASCADE BASE SP? 150 ALARM SETPOINT STATUS OUT%	The base setpoint corresponds to the 0% level output of the primary loop. Enter the base setpoint of the secondary loop. For this example, we will assume a base setpoint of 150° F, which is the desired water temperature. Press **ENTER**.
LOOP PROCESS UNITS 02 CASCADE MIN SP? -350 ALARM SETPOINT STATUS OUT%	Enter the minimum setpoint of the secondary loop. For this example, we will use a minimum setpoint of -350° F. Press **ENTER**.
LOOP PROCESS UNITS 02 CASCADE MAX SP? 1400 ALARM SETPOINT STATUS OUT%	Enter the maximum setpoint of the secondary loop. For this example, we will use a maximum setpoint of 1400° F. Press **ENTER**.
LOOP PROCESS UNITS 02 CASCADE HT SPAN? 40 ALARM SETPOINT STATUS OUT%	Enter the heat span of the secondary loop. This is the span over which the primary output from 0 to 100% is used to change the setpoint. The desired setpoint range is 150 to 190° F. We will assume a linear rise in setpoint, so the heat span is 40° F. Press **ENTER**.
LOOP PROCESS UNITS 02 CASCADE CL SPAN? 0 ALARM SETPOINT STATUS OUT%	Enter the cool span of the secondary loop. For this example we will assume no low-side adjustment to the setpoint, so the cool span is 0° F. Press **ENTER**.

3. Press **BACK** several times until the normal loop display appears. The output percentage of loop 1 will now control the setpoint of loop 2.

To verify that cascade is working as expected, you would follow these steps:

1. Set loop 1 to MANUAL and the OUTPUT to 0%. Loop 2 setpoint should equal 150 (BASE SP).
2. Adjust loop 1 MANUAL OUTPUT to 50%. Loop 2 setpoint should equal 170 (BASE SP + 50% of HT SPAN)
3. Adjust loop 1 MANUAL OUTPUT to 100%. Loop 2 setpoint should equal 190 (BASE SP + HT SPAN).
4. To complete the cascade setup, both loop 1 and loop 2 must be configured for inputs, outputs, and alarms.

In addition, the PID parameters of loop 1 must be tuned to produce the desired effect for the application on the setpoint of loop 2. For a cascade control application that uses the secondary loop for PID control, loop 1 typically uses only proportional mode. This must be set for the amount of change in the process variable to cause a 100% change in the output level.

The proportional band is selected so the setpoint of the secondary loop has the desired relationship to the process variable of the primary loop. In this application, the proportional band (PB) of the primary loop is set to 10˚ F and the integral and derivative are turned off.

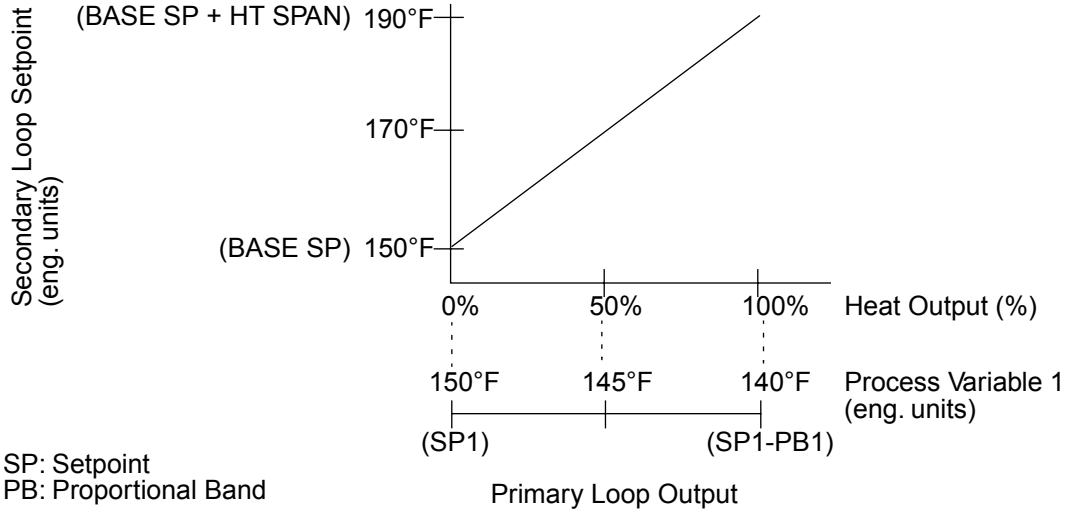


Figure 6.6 Secondary Loop Setpoint Related to Primary Loop Output

As the temperature of loop 1 drops, the output of loop 1 goes up proportionally and the setpoint of loop 2 goes up proportionally. Thus heat is added to the system at the element

even though the temperature near the element may have been at setpoint (150˚ F).

With proportional control, when loop 1 is at setpoint, its output is 0%, and the setpoint of loop 2 is equal to the base setpoint (150˚ F). If the temperature of loop 1 drops to 149˚ F, the deviation results in a proportional output of 10%. This times the span of 40˚ F results in an increase in setpoint for loop 2 of 4˚ F. The loop 2 setpoint increases to 154˚ F. For every degree that loop 1 drops, loop 2 increases by 4˚ F until the output of loop 1 is 100% and the loop 2 setpoint is 190˚ F. Any further drop in the loop 1 process variable does not affect loop 2.

The PID parameters of loop 2 must be tuned to perform efficient control.

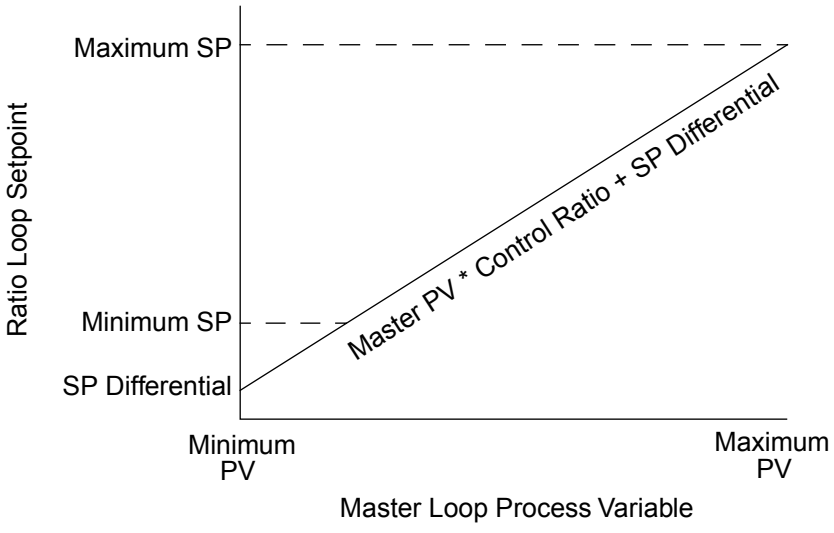
For two-zone cascade control systems, the PID settings for both loops, the primary plus the secondary, must be optimized for good temperature control.

See *Chapter 4, Setup* for information on tuning PID loops.

Ratio Control

Ratio control allows the process variable of one loop (master loop), multiplied by a ratio, to be the setpoint of another loop (ratio loop). You can assign any process variable to determine the setpoint of a ratio loop.

By adjusting the ratio control parameters, you can adjust the influence that the master loop process variable has on the setpoint of the ratio loop.



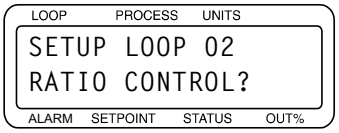
SP: Setpoint
PV: Process Variable

Figure 6.7 Relationship Between the Master Loop's Process Variable and the Ratio Loop's Setpoint

NOTE! ***Ratio control cannot be used on the same control loop as cascade control. However, both features may be used in the same multi-loop controller.***

Setup Loop Ratio Control Menu

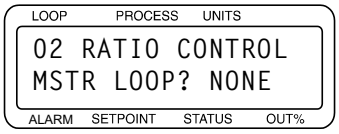
The ratio control parameters appear in the SETUP LOOP RATIO CONTROL menu.



Press **YES** to set up the ratio control parameters with loop number 2 as the ratio loop.

Master Loop

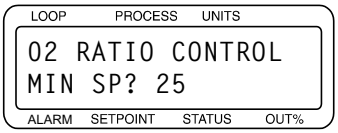
Enter the master loop which will provide the output to the internal controller setpoint calculation for the ratio loop setpoint.



Selectable values: Any loop except the loop currently selected (in this case, loop 02). Choose NONE for no ratio control.

Minimum Setpoint

Enter the lowest allowable setpoint for the ratio loop. This minimum setpoint overrides any ratio calculation calling for a lower setpoint. This value is expressed in the same engineering units as the ratio loop's process variable.

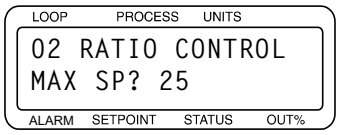


Selectable values: Any value from the minimum value of the ratio loop's process variable to its maximum value.

Maximum Setpoint

Enter the highest allowable setpoint for the ratio loop. This maximum setpoint overrides any ratio calculation calling

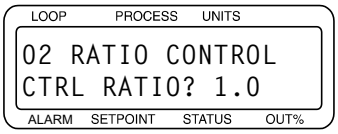
for a higher setpoint. This value is expressed in the same engineering units as the ratio loop's process variable.



Selectable values: Any value from the minimum value of the ratio loop's process variable to its maximum value.

Control Ratio

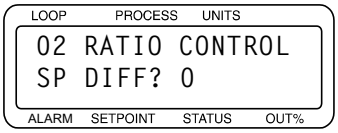
Enter the multiplier to apply to the master loop's process variable.



Selectable values: 0.1 to 999.9.

Setpoint Differential

Enter the value to add or subtract from the ratio loop setpoint calculation before using it as the setpoint. This value is expressed in the same engineering units as the ratio loop's process variable.



Selectable values: -9999 to 9999 with the decimal placement determined by the DISP FORMAT setting for the ratio loop.

Ratio Control Example: Diluting KOH

A chemical process requires a formula of two parts water (H_2O) to one part potassium hydroxide (KOH) to produce diluted potassium hydroxide. The desired flow of H_2O is 10 gallons per second (gps), so the KOH should flow at 5 gps. Separate pipes for each chemical feed a common pipe. The flow rate of each feeder pipe is measured by a CLS200, with H_2O flow as process variable 1 and KOH flow as process variable 2. The outputs of loops 1 and 2 adjust motorized valves.

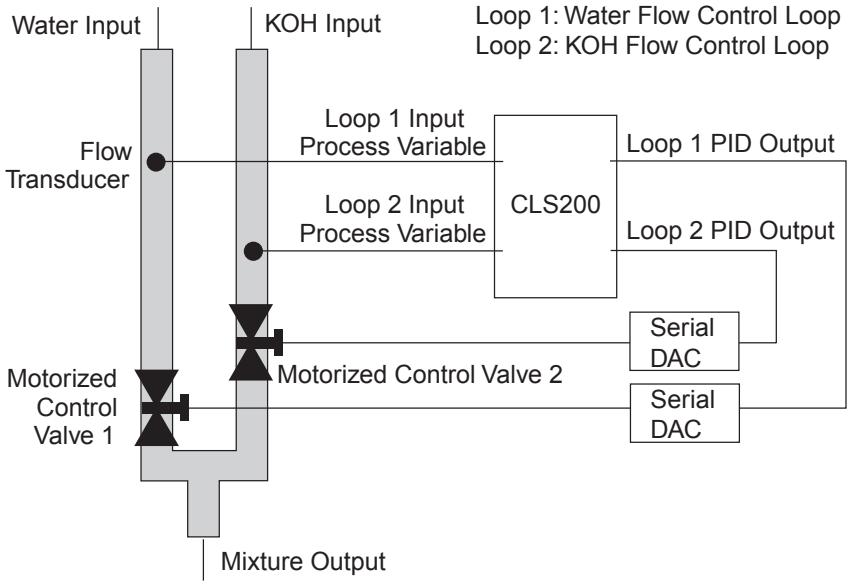
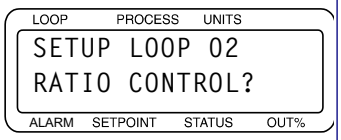
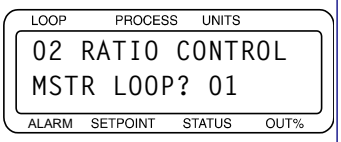
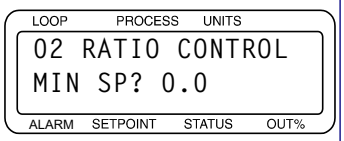
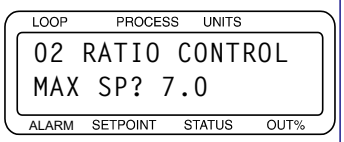
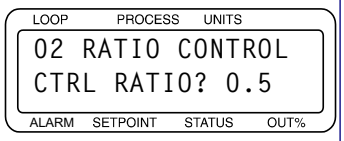
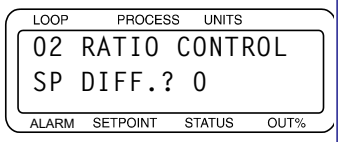


Figure 6.8 Application Using Ratio Control

To set up this application, you would do the following:

1. Adjust and tune loop 1 (H_2O) for optimal performance before implementing the ratio setup.
2. Switch the controller to display loop 2 (KOH), and then enter the three-key sequence (**ENTER**, then **ALARM ACK**, then **CHNG SP**) and go to the first screen in *Table 6.3*.
3. Follow the steps in *Table 6.3* to configure ratio control.

Table 6.3 Application Example: Setting Up Ratio Control

Display	User Input
	Press **YES** to set up the ratio control parameters for loop 02.
	Assign loop 01 as the master loop. Press **ENTER**.
	Enter the minimum ratio loop setpoint. For this example, we will use 0.0 gallons per second as a minimum. Press **ENTER**.
	Enter the maximum ratio loop setpoint. For this example, we will use 7.0 gallons per second as a maximum. Press **ENTER**.
	Enter the control ratio, which is the multiple applied to the master. The H_2O fl w rate is multiplied by 0.5 to obtain the KOH fl w rate setpoint. Press **ENTER**.
	Enter the setpoint differential (or offset). For this example we have no offset requirement and will use 0. Press **ENTER**.

4. Press **BACK** several times until the normal loop display appears. The setpoint of loop 2 will now be equal to one half of the process variable of loop 2.
5. To complete the ratio setup, configure both loops 1 and 2 for inputs, outputs, and alarms. See *Chapter 4, Setup* for information on loop setup.

Remote Analog Setpoint

The remote analog setpoint is set up identically to ratio control. To provide a setpoint remotely, typically a voltage or current source is connected to an analog input on the controller. This input is configured as a linear input type and the master loop for ratio control. All other input types are also usable as remote analog setpoint inputs.

Specify the loop to which the analog input is connected as the master loop and setup the rest of the ratio control parameters as outlined in *Setup Loop Ratio Control Menu on page 125*.

Remote Analog Setpoint Example: Setting a Setpoint with a PLC

Remote analog setpoint allows external equipment, such as a PLC or other control system, to change the setpoint of a loop.

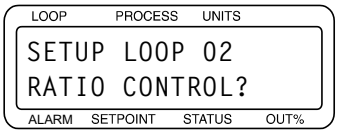
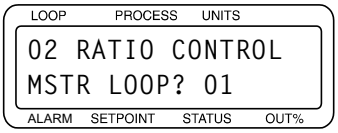
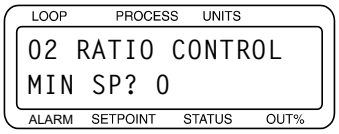
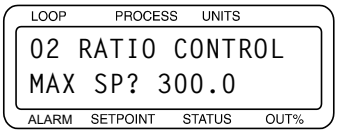
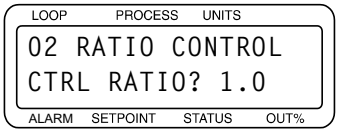
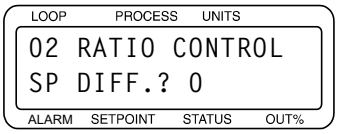
Both the remote analog setpoint feature and the process variable retransmit feature can be used with PLC systems as the link between multiloop PID control systems and PLC systems.

For example, a 0 to 5 V⎓ (dc) signal representing 0 to 300° F will be used as a remote setpoint input to the CLS200. The input signal will be received on loop 1 with the control being performed on loop 2. Note that proper scaling resistors must be installed on the input of loop 1 to allow it to accept a 0 to 5 V⎓ (dc) input.

To set up this application, you would do the following:

1. In the loop 1 `SETUP LOOP INPUT` menu, set the `INPUT TYPE` to `LINEAR`, set `HI PV` to `300`, set `LO PV` to `0`, set `HI RDG` to `100.0%` and set `LO RDG` to `0.0%`.
2. Change the display to loop 2, and then enter the setup parameters. Go to the first screen in *Table 6.4*.
3. Follow the steps in *Table 6.4* to configure the process variable retransmit option.

Table 6.4 Application Example: Setting Up Remote Setpoint

Display	User Input
	Press **YES** to set up the ratio control parameters for loop 2.
	Assign loop 01 to be the master loop. Press **ENTER**.
	Enter the minimum ratio loop setpoint. For this example, we will use 0° F. Press **ENTER**.
	Enter the maximum ratio loop setpoint. For this example, we will use 300.0° F as a maximum. Press **ENTER**.
	Enter the control ratio, which is the multiple applied to the master process variable. In this example the ratio is 1.0. Press **ENTER**.
	Enter the setpoint differential (or offset). For this example we have no offset requirement and will use 0. Press **ENTER**.

4. Press **BACK** several times until the normal loop display appears. The setpoint of loop 2 will now be equal to the process variable of loop 1.
5. To complete the remote analog setpoint setup, loop 1 may be configured for outputs and alarms. Likewise, loop 2 must be configured for inputs, outputs, and alarms. See *Chapter 4, Setup* for information on loop setup.

Differential Control

Differential control is a simple application of the ratio control option, used to control one process (ratio loop) at a differential, or offset, to another (master loop). To use differential control, set the ratio value to 1.0 to provide the desired offset.

Differential Control Example: Thermoforming

A thermal forming application requires that the outside heaters operate at a higher temperature than the center heaters. The differential control point is determined by the master loop which is using infrared (IR) sensors for temperature feedback. Secondary loops use thermocouples for feedback.

The loop using the IR sensor as an input is assigned to the master loop in the SETUP LOOP RATIO CONTROL menu. The secondary loop is the differential control loop. Setting the setpoint differential (SP DIFF) to the desired offset will produce the desired offset between the secondary and master loops.

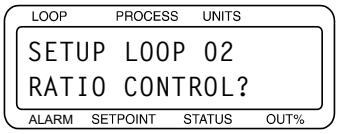
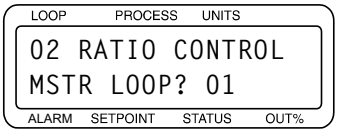
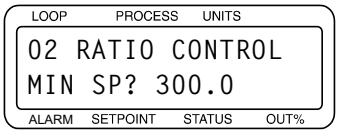
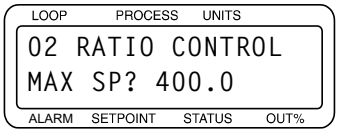
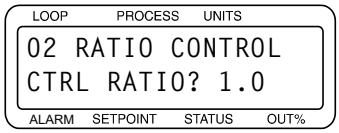
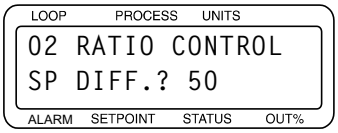
For example, the master loop can be controlled at 325° F and the secondary loop at 375° F by using a differential of 50° F.

Loop 1 must be set up for PID control of the setpoint at 325° F.

To set up this application, you would do the following:

1. Change the display to loop 2, and then enter the setup parameters. Go to the first screen in *Table 6.5*.
2. Follow the steps in *Table 6.5* to configure the process variable retransmit option.

Table 6.5 Application Example: Setting Up Differential Control

Display	User Input
	Press **YES** to setup the ratio control parameters for loop 2.
	Assign loop 01 to be the master loop. Press **ENTER**.
	Enter the minimum ratio loop setpoint. For this example, we will use 300.0° F. Press **ENTER**.
	Enter the maximum ratio loop setpoint. For this example, we will use 400.0° F. Press **ENTER**.
	Enter the control ratio, which is the multiple applied to the master process variable. In this example the ratio is 1.0. Press **ENTER**.
	Enter the setpoint differential (or offset). For this example, we have an offset of +50. Press **ENTER**.

3. Press **BACK** several times until the normal loop display appears. The setpoint of loop 2 will now be equal to process variable of loop 1 plus 50° F.
4. To complete the differential control setup, loop 1 and loop 2 must be configured for inputs, outputs, and alarms. See *Chapter 4, Setup* for information on loop setup.

7

Ramp/Soak

This chapter covers setup and operation of ramp/soak profiles in CLS200 series controllers.

These features are available in controllers that have the optional ramp/soak firmware installed.

The ramp/soak feature turns your controller into a powerful and flexible batch controller. Ramp/soak lets you program the controller to change a process setpoint in a preset pattern over time. This preset pattern, or temperature **profile**, consists of several **segments**. During a segment, the temperature goes from the previous segment's setpoint to the current segment's setpoint.

- If the current segment's setpoint is higher or lower than the previous segment's setpoint, it is called a **ramp** segment.
- If the current segment's setpoint is the same as the previous segment's setpoint, it is called a **soak** segment.

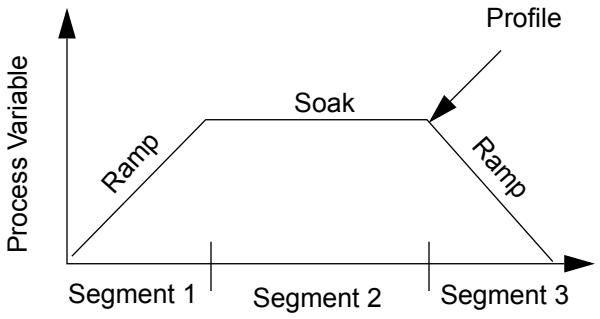


Figure 7.1 Sample Ramp/Soak Profile

Features

Ramp/soak in the CLS200 includes the following features:

- **Ready segment sets loop up for profile:** Ready segment can control at setpoint until profile needs to run. Ready segment events set all available event outputs to desired states before profile starts.
- **Up to 20 segments per profile:** The controller can store up to 17 profiles, each with up to 20 segments.
- **Multiple profiles run independently:** Each loop can run a different profile or the same profile can be run independently on more than one loop.
- **Up to two triggers per segment:** Triggers are digital inputs that can be programmed to start and hold segments based on the trigger's digital state. You can use any one of the eight digital inputs for triggers. You can also use the same trigger for more than one segment or more than one profile.
- **Up to four events per segment:** Digital outputs controlled by the ramp/soak profile. Events outputs are set at the end of a segment. You can use any of the digital outputs that are not used for control or for the Serial DAC clock.
- **Tolerance hold ensures time at temperature:** Set a limit on how far the process variable can vary above or below setpoint. The profile clock only runs when the process variable is within the limit.
- **Tolerance alarm indicates process not tracking setpoint:** Set a maximum amount of time for the tolerance hold to wait for a process deviation before notifying the operator. The operator can acknowledge the alarm and proceed if desired.
- **User-configurable time base:** Program profiles to run for hours and minutes or for minutes and seconds.
- **Repeatable profiles:** Set any profile to repeat from 1 to 99 times or continuously.
- **Fast setup for similar profiles:** Set up one profile, then copy it and alter it to set up the rest.
- **External reset:** Select a digital input you can use to hold a profile in the "start" state and restart it.

Table 7.1 summarizes the ramp/soak features of the CLS200.

Table 7.1 Ramp/Soak Specifications

Number of possible profile	17
Number of times to repeat a profil	1 to 99 or Continuous
Number of segments per profil	1 to 20
Number of triggers per segment	Up to 2
Type of triggers	On, On Latched, Off, Off Latched
Number of possible inputs for triggers	8
Number of events per segment	Up to 4
Number of possible outputs for events (At least one of these outputs must be used for control)	34

Ramp/Soak Menus

The SETUP R/S PROFILES menu appears between the SETUP LOOP ALARMS and MANUAL I/O TEST menus. *Figure 7.2* shows the ramp/soak setup menu tree.

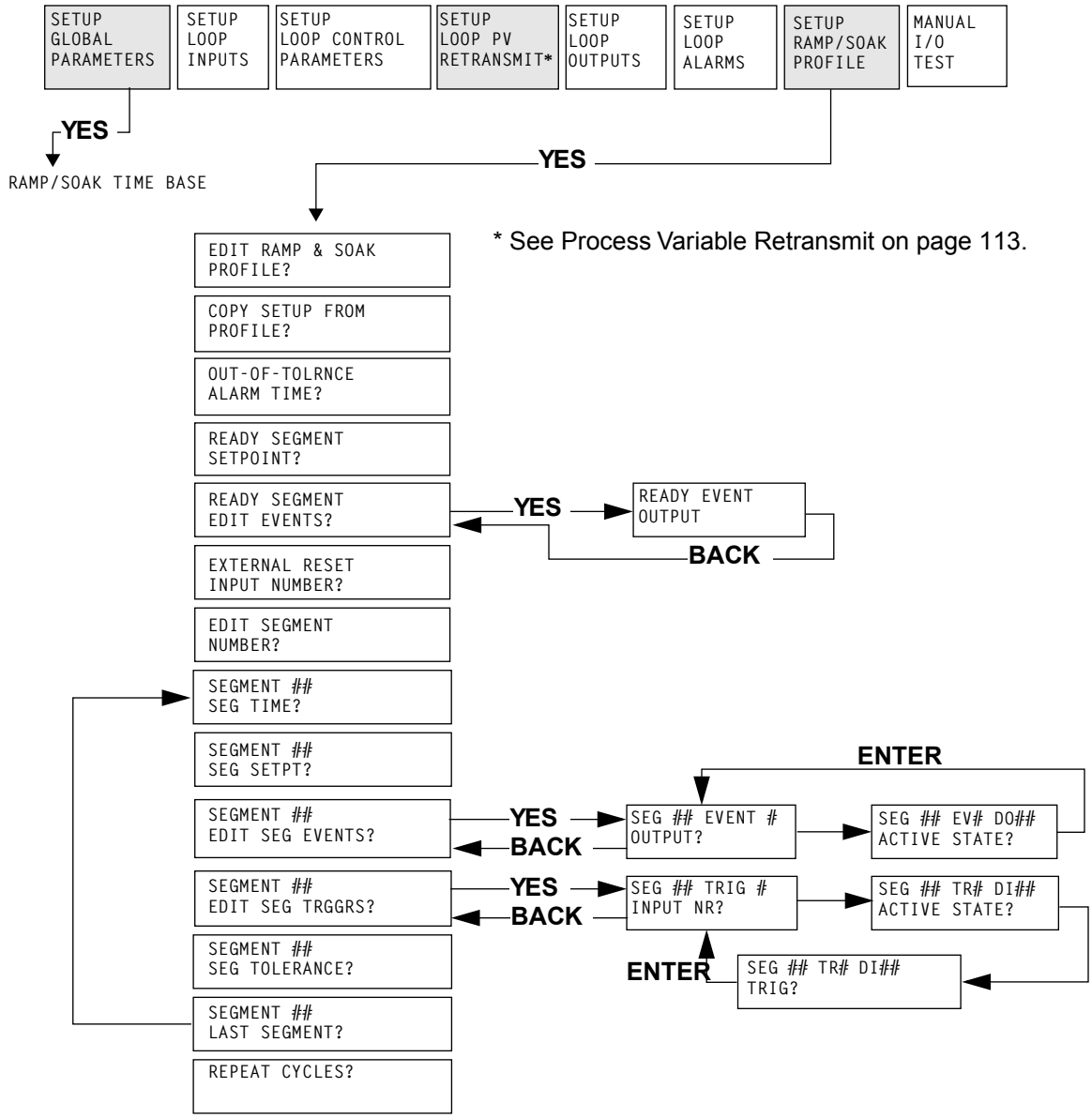


Figure 7.2 Setup Ramp/Soak Profiles Menu

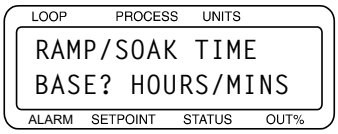
Setup Global Parameters Menu

With the Ramp and Soak option an additional menu appears on the Setup Global Parameters Menu

Ramp/Soak Time Base

The RAMP/SOAK TIME BASE parameter is in the SETUP GLOBAL PARAMETERS menu.

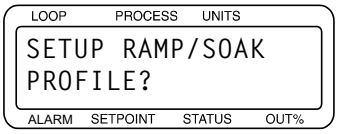
Use this parameter to set the time base in all your ramp/soak profiles. When set to HOURS/MINS, the setpoint is updated once every minute. When set to MINS/SECS, the setpoint is updated once every second.



Selectable values: HOURS/MINS (hours/minutes) or MINS/SECS (minutes/seconds).

Setup Ramp/Soak Profile Menu

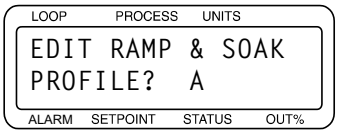
The SETUP RAMP/SOAK PROFILE menu is located between the SETUP LOOP ALARMS and the MANUAL I/O TEST menus if the ramp/soak option is installed.



Press **YES** to set up or edit ramp/soak profiles.

Edit Ramp/Soak Profile

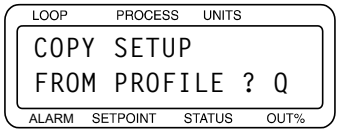
Choose a profile to set up or edit.



Selectable values: A to Q (17 profiles).

Copy Setup From Profile

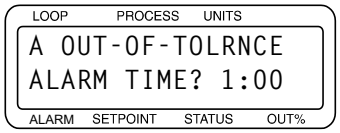
Set up similar profiles quickly by copying the setup of an existing profile.



Selectable values: A to Q.

Tolerance Alarm Time

Set a limit on how long the process variable can be outside the tolerance set for the segment before the tolerance alarm occurs.



If the process variable does not return within the tolerance, the tolerance alarm will recur after the tolerance alarm time elapses again.

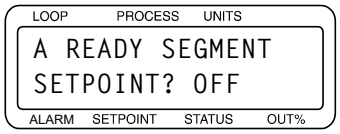
If the alarm persists, you may want to reset the profile.

Selectable values: 0:00 to 99:59 (minutes or hours, depending on the time base setting).

Ready Segment Setpoint

When you assign a profile to a loop, the profile does not start immediately. Instead, it goes to the ready segment (segment 0) and stays there until you put the profile in run mode.

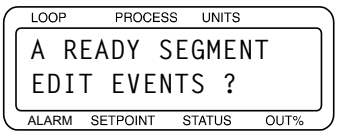
You can set a setpoint, assign events, and set event states for the ready segment. Use this parameter to set the ready segment setpoint. Setting the setpoint to OFF ensures that control outputs for the loop running the profile will not come on.



Selectable values: -999 to 9999, or OFF. See *Setpoints and Tolerances for Various Input Types on page 144.*

Ready Segment Edit Events

Press **YES** to set or edit the ready state for all outputs that are not used for control or for the Serial DAC clock. When you assign a profile, the controller starts the ready segment: it goes to the setpoint and puts all the outputs in the state you set here. The outputs stay in the states they are set to until their states are changed at the end of subsequent segments.

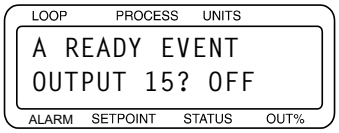


Press **NO** to advance to EXTERNAL RESET INPUT NUMBER.

Ready Event Output

Press **NO** to increment the output number. Press **YES** to set the event state to **ON** or **OFF**.

This parameter appears only if you answered **YES** to READY SEGMENT EDIT EVENTS?.

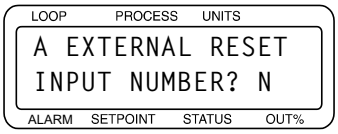


Selectable values: ON or OFF.

When you are done, press **BACK** to return to READY SEGMENT EDIT EVENTS, then press **NO** to go to the next parameter.

External Reset Input Number

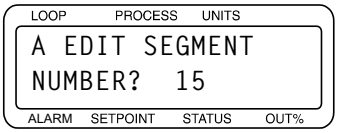
Select one of the eight digital inputs as an external reset. When the reset input is on, the profile is set to RUN mode at the beginning of the first segment. As long as the reset input is on, the profile is held at the beginning of the first segment. Once the reset input turns off the profile begins to run.



Selectable values: 1 to 8, or N (for no external reset).

Edit Segment Number

Each profile is made up of several segments (up to 20). Choose the segment to edit.

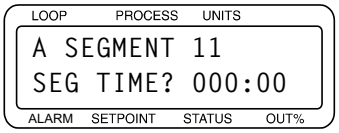


Selectable values: 1 to 20.

The first time you use this parameter, it defaults to segment 1. When you finish editing a segment, the controller goes to the next segment. This loop continues until you make a segment the last segment of a profile.

Segment Time

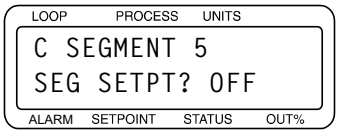
Enter the duration of the segment.



Selectable values: 0:00 to 999:59 (hours and minutes or minutes and seconds, depending on the selected time base).

Segment Setpoint

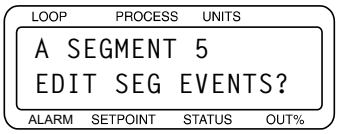
Enter the ending setpoint for the segment you are editing. For a ramp, the setpoint changes steadily over the segment time from the end setpoint of the previous segment to the value set here. For a soak, set the value here equal to the end setpoint of the previous segment.



Selectable values: -999 to 3276, or OFF (no output during segment). See *Setpoints and Tolerances for Various Input Types on page 144*.

Edit Segment Events

You can assign up to four digital outputs, or events, to each segment. When the segment ends, the outputs you select are set to the state you specify. Press **YES** to select outputs and specify their states.



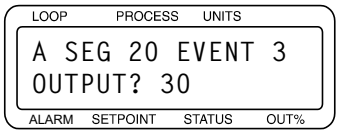
Press **NO** to advance to the EDIT SEG TRGGRS parameter.

NOTE! ***Events are set at the end of segments. If you want a segment to start with an event, program the event in the previous segment. You can also create a segment with zero time preceding the segment during which you want the event on.***

Segment Event Output

Select a digital output for the event. Use a digital output that is not being used for PID control or for Serial DAC clock.

This parameter appears only if you answered **YES** to EDIT SEG EVENTS?



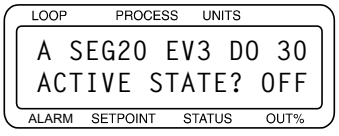
Selectable values: Any digital output from 1 to 34, except those in use, or NONE (no event).

When you are done setting segment events, press **BACK** to return to EDIT SEG EVENTS, then press **NO** to go to the next parameter.

Segment Events Output States

Assign a state to the event. At the end of the segment, the output goes to the state you assign here.

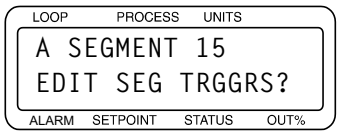
This parameter appears only if you answered **YES** to EDIT SEG EVENTS?



Selectable values: OFF (high) or ON (low).

Edit Segment Triggers

Each segment may have up to two triggers (digital inputs). Both triggers must be true in order for the segment to run. If a trigger is not true, the profile goes into the trigger wait state.

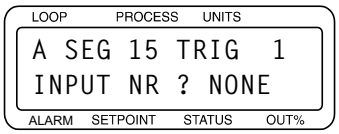


Press **YES** to edit triggers for the current segment, or **NO** to advance to the SEGMENT TOLERANCE parameter.

Trigger Input Number

Assign a digital input to a segment trigger. You can assign any digital input to any trigger. You can also assign the same digital input as a trigger in more than one segment and more than one profile.

This parameter appears only if you answered **YES** to EDIT SEG TRGGRS?



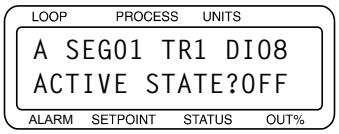
Selectable values: Any digital input from 1 to 8, or NONE (disable trigger).

When you are done editing segment triggers, press **BACK** to return to EDIT SEG TRGGRS.

Trigger Active State

Choose the state that will satisfy the trigger condition. A trigger input is ON when pulled low by an external device. A trigger input is OFF when the digital input is high.

This parameter appears only if you answered **YES** to EDIT SEG TRGGRS?



Selectable values: OFF or ON.

Trigger Latch Status

Choose whether the trigger is latched or unlatched.

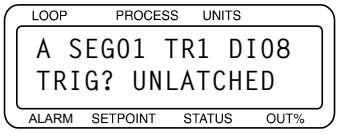
- A latched trigger is checked once, at the beginning of a segment.
- An unlatched trigger is checked constantly while a segment is running. If an unlatched trigger becomes false, the segment timer stops and the loop goes into trigger wait state.

When using two triggers with a segment, the following logic applies:

Table 7.2 Trigger Latch Logic

Trigger Settings	Trigger Logic
Both Triggers Latched	ORed Trigger starts a segment
Both Triggers Unlatched	ANDed Triggers start/continue a segment
One Trigger Latched, One Trigger Unlatched	• The unlatched trigger starts/continues a segment. • The latched trigger has no effect.

This parameter appears only if you answered **YES** to `EDIT SEG TRGGRS?`



Selectable values: `LATCHED` or `UNLATCHED`.

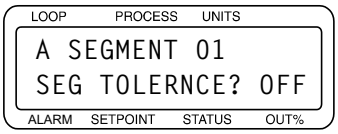
Segment Tolerance

Set a positive or negative tolerance value for each segment. Tolerance works as shown in *Figure 7.3*.

Figure 7.3 Positive and Negative Tolerances

If you enter a positive tolerance, the process is out of tolerance when the process variable goes above the setpoint plus the tolerance.

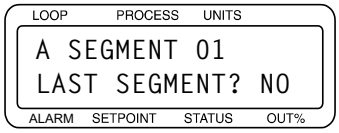
If you enter a negative tolerance, the process goes out of tolerance when the process variable goes below the setpoint minus the tolerance.



Selectable values: -99 to 99, or OFF (no tolerance limit). See *Setpoints and Tolerances for Various Input Types on page 144*.

Last Segment

Specify whether the current segment is the last one in the profile.

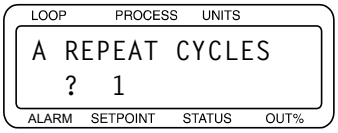


Selectable values: NO or YES.

Repeat Cycles

Set the number of times you want a profile to repeat or cycle.

The profile returns to START mode after completing the number of cycles specified here.



Selectable values: 1 to 99, or C (continuous cycling).

Setpoints and Tolerances for Various Input Types

Setpoints and tolerances are set in segments before the profile is assigned to a particular loop. When the profile is used with a loop, the INPUT TYPE and DISP FORMATS settings are applied to the following parameters:

- Ready setpoint
- Segment setpoint
- Segment tolerance

Refer to *Table 7.3* to determine how these parameters are affected for the various INPUT TYPE and DISP FORMAT settings.

Table 7.3 Display Formats

Input Type	Display Format	Effect on Parameter
Thermocouples and RTDs	N/A	No decimal shift
Linear	-999 to 3000	No decimal shift
	-9999 to 30000	Setting multiplied by 10
	-999.9 to 3000.0	No decimal shift; additional tenth in display
	-99.99 to 300.00	Settings divided by 10
	-9.999 to 30.000	Settings divided by 100
	-0.9999 to 3.0000	Settings divided by 1,000

Using Ramp/Soak

This section explains how to assign a profile to a loop, how to put a profile in RUN or HOLD mode, how to reset a profile, and how to display profile statistics. *Figure 7.4* shows the ramp/soak screens:

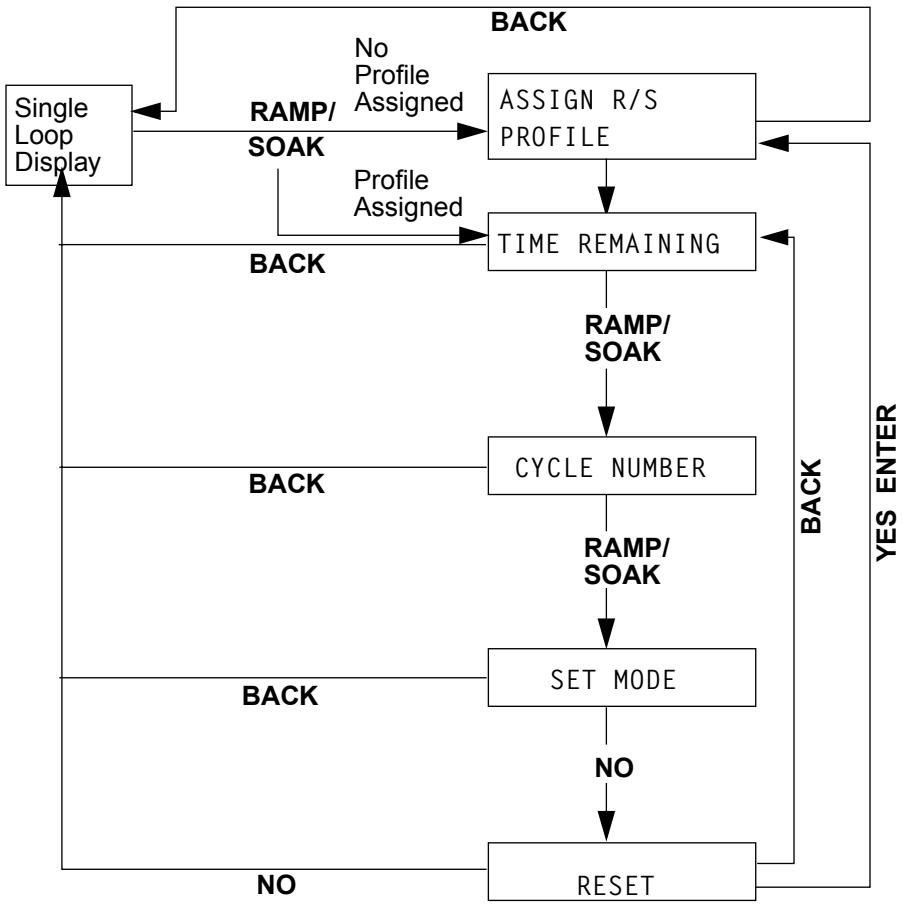


Figure 7.4 Ramp/Soak Screens

Ramp/Soak Displays

The single loop and bar graph displays show additional codes when ramp/soak firmware is installed.

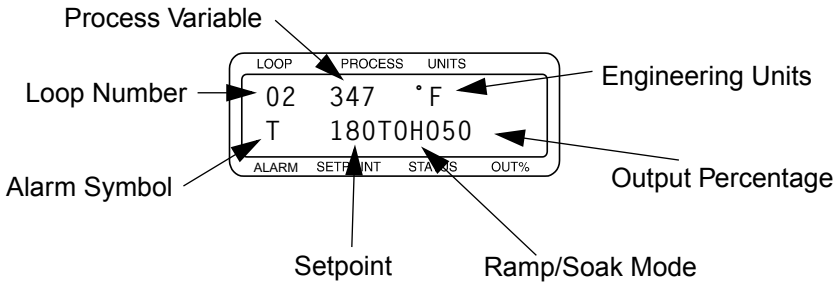
Single Loop Display

When the controller is running a profile, the single loop display shows the ramp/soak mode where it would usually show MAN or AUTO. *Table 7.4* describes the modes.

Table 7.4 Ramp/Soak Single Loop Display

Ramp/Soak Mode	Description
STRT	The profile is in the ready segment
RUN	The profile is unning.
HOLD	The user has put the profile in hold mod .
TOHO	The profile is in tole ance hold.
WAIT	The profile is in t igger wait state.

This is the single loop display when a profile is running. If a tolerance alarm occurs, the controller displays a flashing T in the alarm symbol position.



Bar Graph Display

The ramp/soak mode is also displayed on the bar graph display.

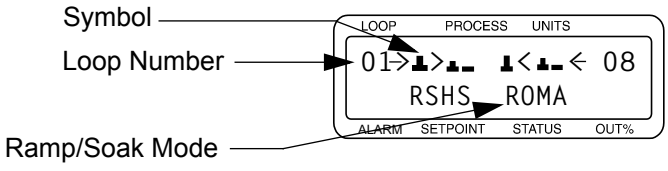


Table 7.5 describes the control status symbols used for loops with ramp/soak profiles assigned.

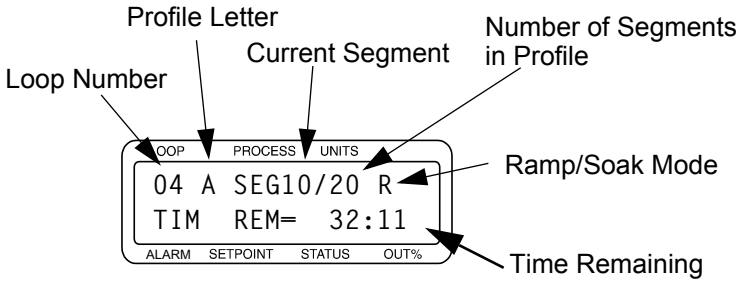
Table 7.5 Ramp/Soak Control Status Symbols

Ramp/Soak Symbol	Description
R	A profile is unning.
H	A profile is holding
S	A profile is in ready stat .
O	A profile is in tole ance hold.
W	A profile is in t igger wait.

Time Remaining Display

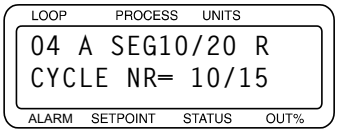
From the single loop display, press the **RAMP/SOAK** key **once**.

This screen shows how much time remains to complete the profile. All screens that are accessed by pressing **RAMP/SOAK** key have the same information on the top line.



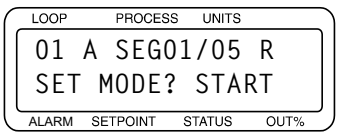
Cycle Number Display

From the single loop display, press the **RAMP/SOAK** key **twice**. This screen displays the number of times the profile has run out of the total number of cycles. In this example, the ramp/soak profile is on the 10th of 15 cycles to be performed.



Set Mode Display

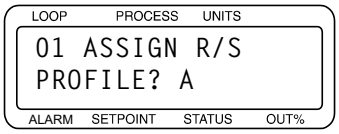
From the single loop display, press the **RAMP/SOAK** key **three** times. The SET MODE parameter allows you to change the ramp/soak mode.



See *Running a Profile on page 148* and *Holding a Profile or Continuing from Hold on page 150* for instructions on changing the ramp/soak mode.

Assigning a Profile to a Loop

Use this parameter to assign a profile to a loop.



Selectable Values: A to Q or NONE

Assigning a Profile the First Time

To assign a profile to a loop that does not have a profile currently assigned:

1. In the single loop display, switch to the loop you want to assign a profile to.
2. Press the **RAMP/SOAK** key. The ASSIGN R/S PROFILE parameter appears.
3. Choose one of the available profiles and press **ENTER**
   - or -
   press **BACK** to return to single loop display without sending profile data to the controller.

Assigning, Changing and Unassigning a Profile

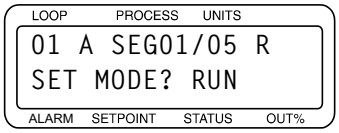
To assign a new profile to a loop that already has one assigned:

1. In the single loop display, switch to the loop in which you want to change or unassign the profile.
2. Press the **RAMP/SOAK** key three times.
3. Press the **NO** key. You will see the RESET PROFILE parameter. See *Resetting a Profile on page 151.*
4. Press **YES** then **ENTER** to reset the profile. You will see the ASSIGN PROFILE parameter. See *Assigning a Profile to a Loop on page 148.*
5. Choose one of the available profiles or NONE (to unassign) and press **ENTER**.
6. To return to the single loop display without changing the profile assignments, press **BACK**.

Running a Profile

When you assign a profile, it does not start running immediately. Instead, the loop is in the START mode and the

READY segment (segment 0). Use the SET MODE parameter to start a profile (put it in RUN mode).



Starting a Profile

You can start a profile only when it is in the READY segment.

1. In the single loop display, switch to the loop you want to start.
2. Press the **RAMP/SOAK** key three times. The SET MODE parameter appears.
3. Press **YES** and **ENTER** to start the profile. While the profile is in START mode, the only mode available is the RUN mode.

Running Several Profiles Simultaneously

To run several profiles simultaneously, follow these steps:

1. Set up the profiles so that segment 1 of each profile has the same latched trigger.
2. Assign the profiles to the appropriate loops. The loops will go to the READY segment of each profile.
3. Set each profile to RUN mode.
4. Trip the trigger.

Editing a Profile While It Is Running

You can edit a profile while it is running. Changes made to segments after the current segment will take effect when the segment is reached. Changes made to the segments that have already been completed will take effect the next time the profile is run. Do not edit the current segment. Changes to the current segment can have unexpected consequences.

Holding a Profile or Continuing from Hold

Use the SET MODE parameter to select the ramp/soak profile mode. *Table 7.6* shows the available modes.

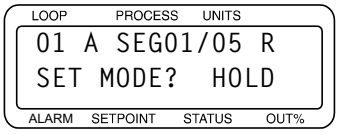
Table 7.6 Ramp/Soak Profile Modes

Current Mode	Available Mode	Description
START	RUN	Begin running the assigned profil .
HOLD	CONT	Continue from user-selected hold. The profile uns from the point when you put the profile in HOLD mode. (You cannot continue from a tolerance hold or a trigger wait.) After you choose this mode, the controller switches back to RUN mode.
RUN	HOLD	Hold the profil .

Holding a Profile

In HOLD mode, all loop parameters stay at their current settings until you change the mode or reset the profile. To put a profile into HOLD mode, follow these steps:

1. In the single loop display, switch to the loop you want to hold.
2. Press the **RAMP/SOAK** key three times to see the SET MODE parameter:



3. Press **YES** to set the mode. While the profile is running, the only mode you will be able select is HOLD.
4. Press **ENTER** to hold the profile.

Continuing a Profile

To resume or continue a profile that is holding:

1. In the single loop display, switch to the loop you want to run.
2. Press the **RAMP/SOAK** key three times. The SET MODE parameter appears.
3. Press **YES** to set the mode. While the profile is holding, the only mode you will be able select is CONT (continue).
4. Press **ENTER** to run the profile.

Responding to a Tolerance Alarm

A tolerance can be set for each segment. The following occurs when the process variable goes outside this tolerance:

- The profile goes into tolerance hold
- The segment timer holds
- The loop's single loop display shows TOHO
- The tolerance alarm timer starts

If the process variable returns within the segment tolerance before the tolerance alarm time elapses, the profile returns to RUN mode and the tolerance alarm timer resets.

The following occurs if the profile remains out of tolerance for longer than the tolerance alarm time:

- The controller displays the single loop display with the tolerance alarm (a flashing T)
- The global alarm output turns on

Press **ALARM ACK** to:

- Turn off the global alarm output
- Reset the tolerance alarm timer
- Clear the tolerance alarm

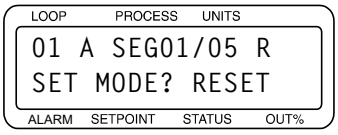
If the process variable does not return within the tolerance, the tolerance alarm will recur after the tolerance alarm time elapses again.

If the alarm persists you may want to reset the profile.

Resetting a Profile

To reset a profile, follow these steps:

1. In the single loop display, switch to the loop you want to reset.
2. Press the **RAMP/SOAK** key three times to see the SET MODE parameter.
3. Press the **NO** key. The following screen will display:



4. Press **YES** to reset the profile, and then **ENTER** to confirm your choice.

When you reset a profile, the following happens:

- The profile returns to the ready segment. The setpoint goes to the ready setpoint, and the event outputs go to the states you specified for the READY EVENT OUTPUT parameter in the READY SEGMENT EDIT EVENTS submenu (See *Ready Segment Edit Events on page 139*.)

- The controller shows you the ASSIGN R/S PROFILE screen in case you would like to assign a different profile to the loop or select NONE to unassign the profile.

In Case of a Power Failure

If the power fails or the controller is otherwise powered down while running a ramp/soak profile, by default the profile is set to the START mode when power is restored.

If the POWER UP OUTPUT STATUS parameter in the SETUP GLOBAL PARAMETERS menu is set to MEMORY, then after a power failure the profile will resume operation at the elapsed time of the segment that was active when the power failure occurred.

8

Tuning and Control

This chapter describes the different methods of control available with the CLS200. This chapter covers control algorithms, control methods, PID control, starting PID values and tuning instructions to help appropriately set control parameters in the CLS200 system. For more information on PID control, consult the *Watlow Anafaze Practical Guide to PID*.

Control Algorithms

This section explains the algorithms available for controlling a loop.

The control algorithm dictates how the controller responds to an input signal. Do not confuse control algorithms with control output signals (for example, analog or pulsed dc voltage). There are several control algorithms available:

- On/off
- Proportional (P)
- Proportional and integral (PI)
- Proportional with derivative (PD)
- Proportional with integral and derivative (PID)

P, PI or PID control is necessary when process variable cycling is unacceptable or if the load or setpoint varies.

NOTE! ***For any of these control statuses to function, the loop must be in automatic mode.***

On/Off Control

On/off control is the simplest way to control a process. The controller turns an output on or off when the process variable reaches limits around the desired setpoint. This limit is adjustable; Watlow Anafaze controllers use an adjustable spread.

For example, if the setpoint is 1,000˚ F and the spread is 20˚ F, the heat output switches on when the process variable drops below 980˚ F and off when the process rises above 1,000˚ F. A process using on/off control cycles around the setpoint. Figure 8.1 illustrates this example.

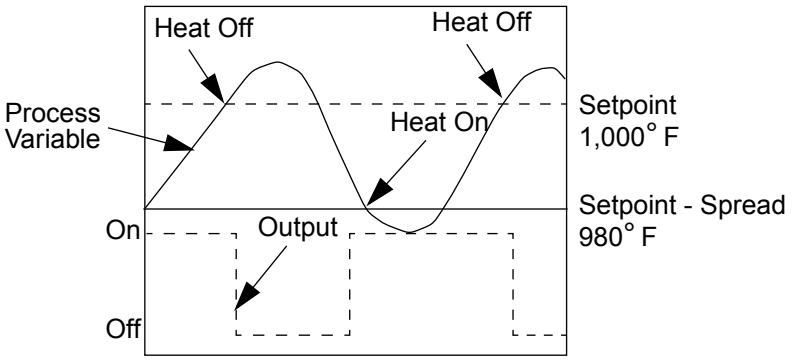


Figure 8.1 On/Off Control

Proportional Control

Proportional control eliminates cycling by increasing or decreasing the output proportionally with the process variable's deviation from the setpoint.

The magnitude of proportional response is defined by the proportional band. Outside this band, the output is either 100% or 0%. Within the proportional band the output power is proportional to the process variable's deviation from the setpoint.

For example, if the setpoint is 1,000˚ F and the proportional band is 20˚ F, the output is:

- 0% when the process variable is 1,000˚ F or above
- 50% when the process variable is 990˚ F
- 75% when the process variable is 985˚ F
- 100% when the process variable is 980˚ F or below

However, a process which uses only proportional control settles at a point above or below the setpoint; it never reaches the setpoint by itself. This behavior is known as *offset* or *droop*.

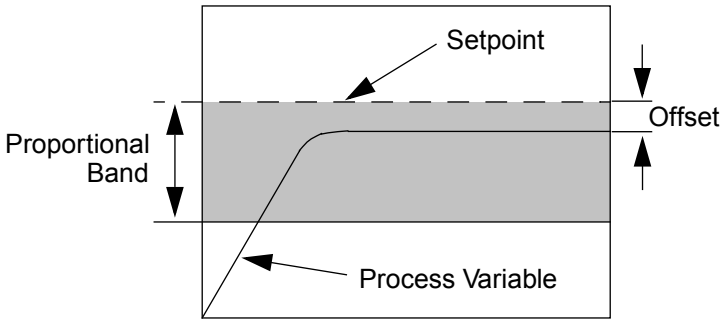


Figure 8.2 Proportional Control

Proportional and Integral Control

With proportional and integral control, the integral term corrects for offset by repeating the proportional band's error correction until there is no error. For example, if a process tends to settle about 5˚ F below the setpoint, appropriate integral control brings it to the desired setting by gradually increasing the output until there is no deviation.

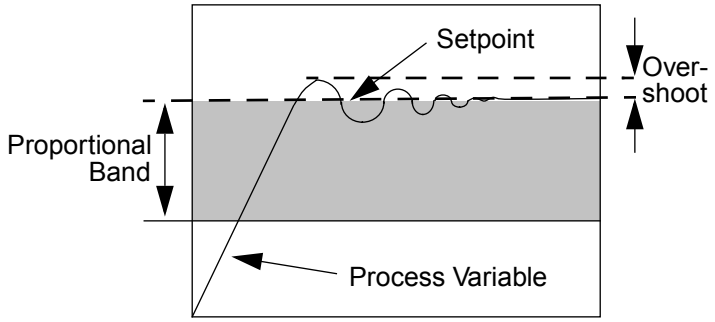


Figure 8.3 Proportional and Integral Control

Proportional and integral action working together can bring a process to setpoint and stabilize it. However, with some processes the user may be faced with choosing between parameters that make the process very slow to reach setpoint and parameters that make the controller respond quickly, but introduce some transient oscillations when the setpoint or load changes. The extent to which these oscillations of the process variable exceed the setpoint is called *overshoot*.

Proportional, Integral and Derivative Control

Derivative control corrects for overshoot by anticipating the behavior of the process variable and adjusting the output appropriately. For example, if the process variable is

rapidly approaching the setpoint from below, derivative control reduces the output, anticipating that the process variable will reach setpoint. Use it to reduce overshoot and oscillation of the process variable common to PI control. *Figure 8.4* shows a process under full PID control.

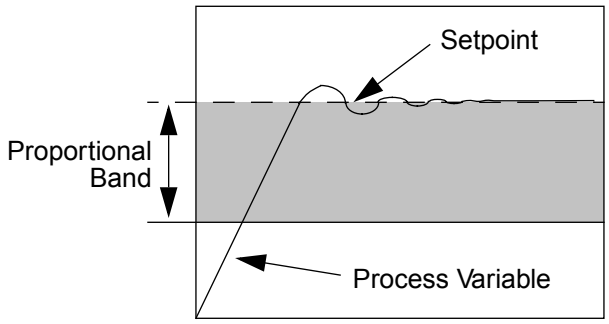


Figure 8.4 Proportional, Integral and Derivative Control

Heat and Cool Outputs

Each loop may have one or two outputs. Often a heater is controlled according to the feedback from a thermocouple, in which case only one output is needed.

In other applications, two outputs may be used for control according to one input. For example, a system with a heater and a proportional valve that controls cooling water flow can be controlled according to feedback from one thermocouple.

In such systems, the control algorithm avoids switching too frequently between heat and cool outputs. The on/off algorithm uses the SPREAD parameter to prevent such oscillations (see *Spread on page 92*). When PID control is used for one or both loop outputs, both the SPREAD parameter and PID parameters determine when control switches between heating and cooling.

Control Outputs

The controller provides open collector outputs for control. These outputs normally control the process using solid state relays.

Open collector outputs can be configured to drive a serial digital-to-analog converter (Serial DAC) which, in turn, can provide 0 to 5 V⎓ (dc), 0 to 10 V⎓ (dc) or 4 to 20 mA control signals to operate field output devices.

Output Control Signals

The following sections explain the different control output signals available.

On/Off

When on/off control is used, the output is on or off depending on the difference between the setpoint and the process variable. PID algorithms are not used with on/off control. The output variable is always off or on (0% or 100%).

Time Proportioning (TP)

With time proportioning outputs, the PID algorithm calculates an output between 0 and 100%, which is represented by turning on an output for that percent of a fixed, user-selected time base or cycle time.

The cycle time is the time over which the output is proportioned, and it can be any value from 1 to 255 seconds. For example, if the output is 30% and the cycle time is 10 seconds, then the output will be on for 3 seconds and off for 7 seconds. *Figure 8.5* shows examples of time proportioning and distributed zero crossing (DZC) waveforms.

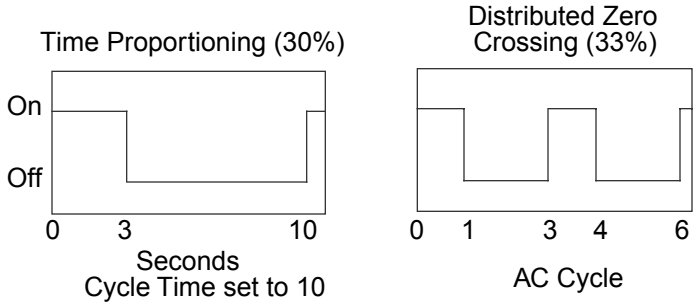


Figure 8.5 Time Proportioning and Distributed Zero Crossing Waveforms

Distributed Zero Crossing (DZC)

With DZC outputs, the PID algorithm calculates an output between 0 and 100%, but the output is distributed on a variable time base. For each ac line cycle, the controller decides whether the power should be on or off. There is no fixed cycle time since the decision is made for each line cycle. When used in conjunction with a zero crossing device, such as a solid state relay (SSR), switching is done only at the zero crossing of the ac line, which helps reduce electrical noise.

Using a DZC output should extend the life of heaters. Since the time period for 60 Hz power is 16.6 ms, the switching interval is very short and the power is applied uniformly. DZC should be used with SSRs. Do not use DZC output for electromechanical relays.

The combination of DZC output and a solid state relay can inexpensively approach the effect of analog, phase-angle fired control. Note, however, DZC switching does not limit the current and voltage applied to the heater as phase-angle firing does.

Three-Phase Distributed Zero Crossing (3P DZC)

This output type performs exactly the same as DZC except that the minimum switching time is three ac line cycles. This may be advantageous in some applications using three-phase heaters and three-phase power switching.

Analog Outputs

For analog outputs, the PID algorithm calculates an output between 0 and 100%. This percentage of the analog output range can be applied to an output device via a Dual DAC or a Serial DAC.

Output Filter

The output filter digitally smooths PID control output signals. It has a range of 0 to 255 scans, which gives a time constant of 0 to 170 seconds for a CLS216, 0 to 85 seconds for a CLS208 or 0 to 43 seconds for a CLS204. Use the output filter if you need to filter out erratic output swings due to extremely sensitive input signals, like a turbine flow signal or an open air thermocouple in a dry air gas oven.

The output filter can also enhance PID control. Some processes are very sensitive and would otherwise require a large proportional band, making normal control methods ineffective. Using the output filter allows a smaller proportional band to be used, achieving better control.

Also, use the filter to reduce the process output swings and output noise when a large derivative is necessary, or to make badly tuned PID loops and poorly designed processes behave properly.

Reverse and Direct Action

With reverse action an increase in the process variable causes a decrease in the output. Conversely, with direct action an increase in the process variable causes an increase in the output. Heating applications normally use reverse action and cooling applications usually use direct action.

Setting Up and Tuning PID Loops

After installing your control system, tune each control loop and then set the loop to automatic control. When tuning a loop, choose PID parameters that will best control the process. This section gives PID values for a variety of heating and cooling applications.

NOTE! ***Tuning is a slow process. After adjusting a loop, allow about 20 minutes for the change to take effect.***

Proportional Band (PB) Settings

Table 8.1 shows proportional band settings for various temperatures in degrees Fahrenheit or Celsius.

Table 8.1 Proportional Band Settings

Temperature Setpoint	PB	Temperature Setpoint	PB	Temperature Setpoint	PB
-100 to 99	20	1100 to 1199	75	2200 to 2299	135
100 to 199	20	1200 to 1299	80	2300 to 2399	140
200 to 299	30	1300 to 1399	85	2400 to 2499	145
300 to 399	35	1400 to 1499	90	2500 to 2599	150
400 to 499	40	1500 to 1599	95	2600 to 2699	155
500 to 599	45	1600 to 1699	100	2700 to 2799	160
600 to 699	50	1700 to 1799	105	2800 to 2899	165
700 to 799	55	1800 to 1899	110	2900 to 2999	170
800 to 899	60	1900 to 1999	120	3000 to 3099	175
900 to 999	65	2000 to 2099	125	3100 to 3199	180
1000 to 1099	70	2100 to 2199	130	3200 to 3299	185

As a general rule, set the proportional band to 10% of the setpoint below 1000˚ and 5% of the setpoint above 1000˚. This setting is useful as a starting value.

Integral Settings

The controller's integral parameter (TI) is set in seconds per repeat. Some other products use an integral term called reset, in units of repeats per minute. *Table 8.2* shows integral settings versus reset settings.

Table 8.2 Integral Term and Reset Settings

Integral (Seconds/Repeat)	Reset (Repeats/Minute)	Integral (Seconds/Repeat)	Reset (Repeats/Minute)
30	2.0	210	0.28
45	1.3	240	0.25
60	1.0	270	0.22
90	0.66	300	0.20
120	0.50	400	0.15
150	0.40	500	0.12
180	0.33	600	0.10

As a general rule, use 60, 120, 180 or 240 as a starting value for the integral.

Derivative Settings

The controller's derivative parameter (TD) is programmed in seconds. Some other products use a derivative term called rate programmed in minutes. Use the table or the formula to convert parameters from one form to the other. *Table 8.3* shows derivative versus rate. Rate = Derivative/60.

Table 8.3 Derivative Term Versus Rate

Derivative (seconds)	Rate (minutes)	Derivative (seconds)	Rate (minutes)
5	0.08	35	0.58
10	0.16	40	0.66
15	0.25	45	0.75
20	0.33	50	0.83
25	0.41	55	0.91
30	0.50	60	1.0

As a general rule, set the derivative to 15% of integral as a starting value.

NOTE! ***While the basic PID algorithm is well defined and widely recognized, various controllers implement it differently. Parameters may not be taken from one controller and applied to another with optimum results even if the above unit conversions are performed.***

General PID Constants by Application

This section gives PID values for many applications. They are useful as control values or as starting points for PID tuning.

Proportional Band Only (P)

Set the proportional band to 7% of the setpoint. (Example: Setpoint set to 450, proportional band set to 31).

Proportional with Integral (PI)

- Set the proportional band to 10% of setpoint. (Example: Setpoint set to 450, proportional band set to 45).
- Set integral to 60.
- Set derivative to Off.
- Set the output filter to 2.

PI with Derivative (PID)

- Set the proportional band to 10% of the setpoint. (Example: Setpoint set to 450, proportional band set to 45).
- Set the integral to 60.
- Set the derivative to 15% of the integral. (Example: Integral set to 60, derivative set to 9).
- Set the output filter to 2.

Table 8.4 on page 162 shows general PID constants by application.

Table 8.4 General PID Constants

Application	Proportional Band	Integral	Derivative	Filter	Output Type	Cycle Time	Action
Electrical heat with solid state relays	50°	60	15	4	DZC	-	Reverse
Electrical heat with electrome-chanical relays	50°	60	15	6	TP	20	Reverse
Cool with sole-noid valve	70°	500	90	4	TP	10	Direct
Cool with fans	10°	Off	10	4	TP	10	Direct
Electric heat with open heat coils	30°	20	Off	4	DZC	-	Reverse
Gas heat with motorized valves Setpoint>1200	60° 100°	120 240	25 40	8	Analog	-	Reverse

9

Troubleshooting and Reconfiguring

When There is a Problem

The controller is only one part of your control system. Often, what appears to be a problem with the controller is really a problem with other equipment, so check these things first:

- Controller is installed correctly. (See *Chapter 2, Installation* for help.)
- Sensors, such as thermocouples and RTDs, are installed correctly and working.

NOTE! ***If you suspect your controller has been damaged, do not attempt to repair it yourself, or you may void the warranty.***

If the troubleshooting procedures in this chapter do not solve your system's problems, call Application Engineering for additional troubleshooting help. If you need to return the unit to Watlow Anafaze for testing and repair, Customer Service will issue you an RMA number. See *Returning Your Unit on page 164*.

CAUTION! ***Before trying to troubleshoot a problem by replacing your controller with another one, first check the installation. If you have shorted sensor inputs to high voltage lines or a transformer is shorted out, and you replace the controller, you will risk damage to the new controller.***

If you are certain the installation is correct, you can try replacing the controller. If the second unit works correctly, then the problem is specific to the controller you replaced.

Returning Your Unit

Before returning a controller, contact your supplier or call Watlow for technical support.

Controllers purchased as part of a piece of equipment must be serviced or returned through the equipment manufacturer. Equipment manufacturers and authorized distributors should call customer service to obtain a return materials authorization (RMA) number. Shipments without an RMA will not be accepted. Other users should contact their suppliers for instructions on returning products for repair.

Troubleshooting Controllers

A problem may be indicated by one or more of several types of symptoms:

- A process or deviation alarm
- A failed sensor alarm
- A system alarm
- Unexpected or undesired behavior

The following sections list symptoms in each of these categories and suggest possible causes and corrective actions.

Process and Deviation Alarms

When a process or deviation alarm occurs, the controller switches to the single loop display for the loop with the alarm and displays the alarm code on the screen. Software such as AnaWin or WatView displays a message on the alarm screen and logs the alarm in the event log.

Table 9.1 Controller Alarm Codes for Process and Deviation Alarms

Code	Alarm	Description
HP	High Process	Process variable has risen above the high process alarm setpoint.
HD	High Deviation	Process variable has risen above the setpoint by more than the deviation alarm value.
LD	Low Deviation	Process variable has dropped below the setpoint by more than the deviation alarm value.
LP	Low Process	Process variable has dropped below the low process alarm setpoint.

Responding to Process and Deviation Alarms

In a heating application, a low process or low deviation alarm may indicate one of the following:

- The heater has not had time to raise the temperature.
- The load has increased and the temperature has fallen.
- The control status is set to manual instead of automatic.
- The heaters are not working due to a hardware failure.
- The sensor is not placed correctly and is not measuring the load's temperature.
- The deviation limit is too narrow.
- The system is so poorly tuned that the temperature is cycling about setpoint by more than the alarm limit.

NOTE! ***In cooling applications, similar issues cause high process and high deviation alarms.***

In a heating application, a high process alarm or high deviation alarm may indicate one of the following:

- The setpoint and high process limit have been lowered and the system has not had time to cool to within the new alarm limit.
- The control status is set to manual and the heat output is greater than 0%.
- The load has decreased such that the temperature has risen.
- The heater is full-on due to a hardware failure.
- The system is so poorly tuned that the temperature is cycling about setpoint by more than the alarm limit.

Resetting a Process or Deviation Alarm

Your response to an alarm depends upon the alarm type setting, as explained in *Table 9.2* below.

Table 9.2 Operator Response to Alarms

Alarm Type	Operator Response
Control	The operator does not need to do anything. The alarm clears automatically when the process variable returns within limits.
Alarm	Acknowledge the alarm by pressing **ALARM ACK** on the controller or by using software. The alarm clears after the process variable returns within the limits and the operator has acknowledged it.

Failed Sensor Alarms

When a failed sensor alarm occurs, the controller switches to the single loop display for the loop with the alarm and displays an alarm code on the screen. AnaWin or WatView displays a message on the alarm screen and logs the alarm in the event log.

Table 9.3 Failed Sensor Alarm Codes

Code	Alarm	Description
FS	Failed Sensor	Open thermocouple.
RT	Reversed Thermocouple	Temperature changed in the opposite direction than expected.
ST	Shorted Thermocouple	Temperature failed to change as expected.
RO	RTD Open	Positive or negative lead is broken or disconnected.
RS	RTD Shorted	Positive and negative leads are shorted.

A failed sensor alarm clears once it has been acknowledged and the sensor is repaired.

System Alarms

If the controller detects a hardware problem, it displays a message. The message persists until the condition is corrected.

Table 9.4 Hardware Error Messages

Message	Possible Cause	Recommended Action
LOW POWER	Power supply failed.	See *Low Power on page 168*.
BATTERY DEAD	RAM battery is dead.	See *Battery Dead on page 168*.
AW	Ambient warning. Ambient temperature exceeds operating limits by less than 5° C (9° F).	See *Ambient Warning on page 168*.
H/W AMBIENT FAILURE	Ambient temperature exceeds operating limits by 5° C (9° F). Reference voltage (5V⎓ [dc]) shorted to common. Hardware failed due to excessive voltage on inputs.	See *H/W Ambient Failure on page 169*.
H/W GAIN FAILURE	Hardware failed due to excessive voltage on inputs.	See *H/W Gain or Offset Failure on page 170*.
H/W OFFSET FAILURE	Hardware failed due to excessive voltage on inputs.	See *H/W Gain or Offset Failure on page 170*.

Other Behaviors

The following table indicates potential problems with the system or controller and recommends corrective actions.

Table 9.5 Other Symptoms

Symptom	Possible Causes	Recommended Action
Indicated temperature not as expected	Controller not communicating Sensor wiring incorrect Noise	See *Checking Analog Inputs on page 171*.
CLS 200 display is not lit	Power connection incorrect	Check wiring and service. See *Wiring the Power Supply on page 25*.
	No EPROM or bad EPROM	Replace the EPROM. See *Replacing the EPROM on page 176*.
	CLS200 damaged or failed	Return the CLS200 for repair. See *Returning Your Unit on page 164*.
CLS200 display is lit, but keys do not work	Keypad is locked	See *Keys Do Not Respond on page 170*.
	CLS200 damaged or failed	Return the CLS200 for repair. See *Returning Your Unit on page 164*.
Control status of one or more loops changes from automatic to manual	Failed sensor	Check the display or software for a failed sensor message.
	Digital job select feature is enabled and has changed jobs	Set `JOB SELECT DIG INPUTS` to `NONE`. This parameter is only accessible using the controller's keypad and display. See *Job Select Digital Inputs on page 76*.
All loops are set to manual 0%	Power is intermittent	Check wiring and service. See *Wiring the Power Supply on page 25*. Use a separate dc supply for the controller. Provide backup power (UPS). Set `POWER UP OUTPUT STATUS` to `MEMORY`. See *Power Up Output Status on page 78*.
	Analog reference voltage is overloaded	Disconnect any wiring from the +5V Ref connection on TB1.
	Hardware failure	Check the controller front panel for a hardware alarm. See *System Alarms on page 166*.
Controller does not behave as expected	Corrupt or incorrect values in RAM	Perform a **NO**-key reset. See *NO-Key Reset on page 176*.

Corrective and Diagnostic Procedures

The following sections detail procedures you may use to diagnose and correct problems with the controller.

Low Power

If the controller displays LOW POWER or the display is not lit:

1. Acknowledge the alarm.
2. If the error message remains, turn the power to the controller off, then on again.
3. If the error message returns, check that the power supplied to the controller is at least 12.0V⎓ (dc) @ 1 A. See *Wiring the Power Supply on page 25*.
4. If the error message returns again, make a record of the settings if possible (using software). Then, perform a **NO**-key reset (see *NO-Key Reset on page 176*).
5. If the error is not cleared, contact your supplier for further troubleshooting guidance. See *Returning Your Unit on page 164*.

Battery Dead

The dead battery alarm indicates that the CLS200 battery is not functioning correctly or has low power or no power. If this alarm occurs, parameters have reset to the factory default settings.

NOTE! ***The controller will retain its settings when powered. The battery is required to keep the settings in memory only when the controller is powered down.***

If the controller displays BATTERY DEAD:

1. Acknowledge the alarm.
2. If the error message remains, turn the power to the controller off, then on again.
3. If the error message returns when power is restored, perform a **NO**-key reset. See *NO-Key Reset on page 176.*
4. If the error is not cleared, contact your supplier for further troubleshooting guidelines. See *Returning Your Unit on page 164.*

Ambient Warning

The ambient warning alarm indicates that the ambient temperature of the controller is too hot or too cold. Ambient warning occurs when the controller's temperature is in the

range of 23 to 32° F or 122 to 131° F (-5 to 0° C or 50 to 55° C). The operating limits are 32 to 122° F (0 to 50° C).

If the controller displays AW in the lower left corner of the display:

1. Acknowledge the alarm.
2. If the error message remains, check the ambient air temperature near the controller. Adjust ventilation, cooling or heating to ensure that the temperature around the controller is 32 to 122° F (0 to 50° C). If the unit is functioning correctly, the error will clear when the ambient temperature is within range and the alarm has been acknowledged.
3. If the ambient temperature is within range and the error persists:
   a) Turn the power to the controller off.
   b) Remove the boards from the CLS200 housing. See *Replacing the EPROM on page 176.*
   c) Reseat the boards and turn the power on.
4. If the error persists, make a record of the settings then perform a **NO**-key reset. See *NO-Key Reset on page 176.*
5. If the error is not cleared, contact your supplier for further troubleshooting guidelines. See *Returning Your Unit on page 164.*

H/W Ambient Failure

The hardware ambient failure alarm indicates that the ambient sensor in the CLS200 is reporting that the temperature around the controller is outside of the acceptable range of 0 to 50° C. This error can also occur when there is a hardware failure.

If the controller displays H/W AMBIENT FAILURE:

1. Acknowledge the alarm.
2. If the error message remains, check the ambient air temperature near the controller. Adjust ventilation, cooling or heating to ensure that the temperature around the controller is 0 to 50° C. If the unit is functioning correctly, the error will clear automatically when the ambient temperature is within range and the alarm has been acknowledged.
3. Remove any connections to the 5V⎓ (dc) reference (TB1-18) on the back of the controller. If this corrects the problem, there was an error in the wiring. You may need to consult technical support to determine the correct wiring.
4. If the ambient temperature is within range and the error persists:

a) Turn the power to the controller off.

b) Remove the boards from the CLS200 housing.

c) Reseat the boards and turn power on.

5. If the error persists, make a record of the settings, then perform a **NO**-key reset. See *NO-Key Reset on page 176*.
6. If the error is not cleared, contact your supplier for further troubleshooting guidelines. See *Returning Your Unit on page 164*.

NOTE! ***If the controller has failed, it is likely that it was damaged by excessive voltage or noise. Before replacing the controller, troubleshoot for noise and ground loops.***

H/W Gain or Offset Failure

If the controller displays `H/W GAIN FAILURE` or `H/W OFFSET FAILURE`:

1. Acknowledge the alarm.
2. If the error message remains, turn the power to the controller off, then on again.
3. If the H/W Gain error is reported, remove any connections to the 5V⎓ (dc) reference (TB1-18) on the back of the controller. If this corrects the problem, there was an error in the wiring. You may need to consult technical support to determine the correct wiring.
4. If the error persists, make a record of the settings (using software), then perform a **NO**-key reset. See *NO-Key Reset on page 176*.
5. If the error is not cleared, contact your supplier for further troubleshooting guidelines. See *Returning Your Unit on page 164*.

NOTE! ***If the controller has failed, it is likely that it was damaged by excessive voltage or noise. Before replacing the controller, troubleshoot for noise and ground loops.***

Keys Do Not Respond

If the CLS200 seems to function but the **MAN/AUTO**, **CHNG SP**, **ALARM ACK**, and **RAMP/SOAK** keys do not respond when you press them, the keypad is probably locked. Unlock the keypad according to the instructions in *Keyboard Lock Status on page 78*.

Checking Analog Inputs

If the process variable displayed in the software and on the controller do not agree:

1. Verify that the controller is communicating.
2. If the process variable indicated on the controller display is incorrect:
   a) Verify that you have selected the correct input type for the affected loops.
   b) Verify that sensors are properly connected.
3. If the sensors are correctly connected, with power on to the heaters check for high common mode voltage:
   a) Set a voltmeter to measure volts ac.
   b) Connect the negative lead to a good earth ground.
   c) One by one, check each input for ac voltage by connecting the positive lead on the voltmeter to the positive and negative sensor input connections. The process variable should indicate ambient temperature. If it does not, contact your supplier to return the unit for repair. See *Returning Your Unit on page 164.*

NOTE! ***Noise in excess of 1V~ (ac) should be eliminated by correctly grounding the CLS200. See Wiring the Power Supply on page 25.***

4. Verify the sensors:
   - For thermocouples, remove the thermocouple leads and use a digital voltmeter to measure the resistance between the positive and negative thermocouple leads. A value of 2 to 20 Ω is normal. Readings in excess of 200 Ω indicate a problem with the sensor.
   - For RTDs, measure between the IN+ and IN- terminals of TB1. RTD inputs should read between 20 and 250 Ω.
5. To verify that the controller hardware is working correctly, check any input (except the pulse input or an RTD) as follows:
   a) Disconnect the sensor wiring.
   b) Set the `INPUT TYPE` to `J T/C` in the `SETUP LOOP INPUT` menu.
   c) Place a short across the input. The controller should indicate the ambient temperature on the channel you are testing.

Earth Grounding

If you suspect a problem with the ac ground or a ground loop:

- Measure for ac voltage between ac neutral and panel chassis ground. If ac voltage above 2V~ (ac) is observed, then there may be a problem with the ac power wiring. This should be corrected per local electrical codes.
- With ac power on, measure for ac voltage that may be present between control panels' chassis grounds. Any ac voltage above 2V~ (ac) may indicate problems with the ac ground circuit.
- Check for ac voltage on thermocouples with the heater power on. A control output providing power to the heaters will increase the ac voltage if there is heater leakage and an improper grounding circuit. Measure from either positive or negative thermocouple lead to ac ground. AC voltage above 2V~ (ac) may indicate the ground lead is not connected to the CLS200 TB2 ground terminal.

If the above tests indicate proper ac grounding but the controller is indicating incorrect temperatures or process readings:

- Verify which type of sensor is installed and that the `INPUT TYPE` parameter is set accordingly.
- For an RTD or linear voltage or current input, check that the correct input scaling resistors are installed (*page 180*) and check the input scaling parameter settings (*page 86*).
- If readings are erratic, look for sources of electrical noise. See *Noise Suppression on page 22*.
- Eliminate possible ground loops. See *Ground Loops on page 24*.
- Contact your supplier for further troubleshooting guidance. See *Returning Your Unit on page 164.*

Checking Control Outputs

To check control outputs:

- Set the loop you want to check to manual mode.
- Set the output power percentage to the desired level.
- Set the output type to `ON/OFF` or `TP` (see *Chapter 4, Setup*).

If the control output is not connected to an output device like an SSR, connect an LED in series with a 1 kΩ resistor from +5V to the output. (Tie the anode of the LED to +5V.) The LED should be off when the output is 0% and on when the output is 100%.

Testing Control Output Devices

Connect the solid state relay (SSR) control terminals to the CLS200 control output and connect a light bulb (or other load that can easily be verified) to the output terminals on the SSR. Put the loop in manual mode and set the output to 100%. The ac load should turn on.

Do not attempt to measure ac voltage at the SSR's output terminals. Without a load connected, the SSR's output terminals do not turn off. This makes it difficult to determine whether the SSR is actually working. Measure the voltage across a load or use a load that can be visually verified, such as a light bulb.

Testing the TB18 and TB50

1. Turn on power to the controller.
2. Measure the +5V⎓ (dc) supply at the TB18 or TB50. The voltage should be +4.75 to +5.25V⎓ (dc):
   a) Connect the voltmeter's common lead to the TB18 screw terminal 2 or TB50 screw terminal 3.
   b) Connect the voltmeter's positive lead to the TB18 or TB50 screw terminal 1.

Testing Control and Digital Outputs

1. Turn off power to the controller.
2. Disconnect any process output wiring on the output to be tested.
3. Connect a 500 Ω to 100 kΩ resistor between the +5V terminal (TB18 or TB50 screw terminal 1) and the output terminal you want to test.
4. Connect the voltmeter's common lead to the output terminal, and connect the voltmeter's positive lead to the +5V terminal.
5. Restore power to the controller.
6. If you are testing a PID control output, use the **MAN/AUTO** key to turn the output on (100%) and off (0%). When the output is off, the output voltage should be less than 1V. When the output is on, the output voltage should be between +3.75 and +5.25V.
7. If you are testing a digital output not used for control, use the MANUAL I/O TEST menu to turn the output on and off. See *Manual I/O Test on page 103*.

Testing Digital Inputs

1. Turn off power to the controller.
2. Disconnect any system wiring from the input to be tested.

3. Restore power to the controller.
4. Go to the DIGITAL INPUTS parameter in the MANUAL I/O TEST menu. This parameter shows whether the digital inputs are H (high, or open) or L (low, or closed).
5. Attach a wire to the terminal of the digital input to test. When the wire is connected only to the digital input terminal, the DIGITAL INPUTS parameter should show that the input is H (high). When you connect the other end of the wire to controller common (TB50 terminal 3), the DIGITAL INPUTS parameter should show that the input is L (low).

Additional Troubleshooting for Computer Supervised Systems

These four elements must work properly in a computer-supervised system:

- The controller
- The computer and its EIA/TIA-232 or EIA/TIA-485 serial interface
- The EIA/TIA-232 or EIA/TIA-485 communication lines
- The computer software

For troubleshooting, disconnect the communications line from the computer and follow the troubleshooting steps in the first section of this chapter. The next few sections explain troubleshooting for the other elements of computer supervised systems.

Computer Problems

If you are having computer or serial interface problems, check the following:

- Check your software manual and make sure your computer meets the software and system requirements.
- Check the communications interface, cables, and connections. Make sure the serial interface is set according to the manufacturer's instructions.
- To test an EIA/TIA-232 interface, purchase an EIA/TIA-232 tester with LED indicators. Attach the tester between the controller and the computer. When the computer sends data to the controller, the tester's TX LED should blink. When the computer receives data from the controller, the RX LED should blink.
- You can also connect an oscilloscope to the transmit or receive line to see whether data is being sent or received. If the serial port does not appear to be working, the software setup may need to be modified or the hardware may need to be repaired or replaced.

Communications

Most communications problems are due to incorrect wiring or incorrectly set communications parameters. Therefore, when there is a problem, check the wiring and communications settings first. Verify the following:

- Communications port: Software must be configured to use the communications port to which the controller is connected.
- Software protocol: Set the controller to MOD (Modbus) for AnaWin or WatView, ANA (Anafaze) for Anasoft or Anascan.
- Controller address: Configure software to look for the controller at the correct address. In a multiple-controller installation, each controller must have a unique address.
- Baud rate: Software and controller must be set the same.
- Error checking (ANA protocol only): Software and controller must be set the same (CRC or BCC).
- Hardware protocol: PC and controller must use the same protocol, or a converter must be used. The controller is typically configured for EIA/TIA-232 when it is shipped. See *Changing Communications on page 179* to change between EIA/TIA-232 and EIA/TIA-485. To communicate with more than one controller, or when more than 50 feet of cable is required, use EIA/TIA-485. Even for a single controller, you may use EIA/TIA-485 and an optically isolating converter to eliminate ground loops.
- Converter: Make sure that the EIA/TIA-232-to-485 converter is powered, configured and wired correctly.
- Cables: Check continuity by placing a resistor across each pair of wires and measuring the resistance with an ohmmeter at the other end.

Ground Loops

Many PC communications ports have their common wires connected to chassis ground. Once connected to the controller, this can provide a path to ground for current from the process that can enter the controller through a sensor (such as a thermocouple). This creates a ground loop that can affect communications and other controller functions. To eliminate a ground loop, either use an optically isolated communications adapter or take measures to ensure that sensors and all other connections to the controller are isolated and not conducting current into the unit.

Software Problems

If the controller and serial communications connections seem to be working correctly, but you are still not getting the result you expect, consult the resources you have available for the software program you are using.

WatView, AnaWin or Anasoft

Consult the AnaWin or Anasoft User's Guide for help with the user interface. WatView comes with a context-sensitive help explaining operation of the software. Context-sensitive means that you can press the F1 key to get help related to the part of the program you are using.

User-Written Software

You can request a communications specification from Watlow Anafaze if you want to write your own software. Watlow Anafaze will answer technical questions that arise during your software development process, but does not otherwise support user-developed or third-party software in any way.

NO-Key Reset

Performing a **NO**-key reset returns all controller settings to their defaults. All recipes are also cleared.

To perform a **NO**-key reset:

1. Make a record of the controller's settings.
2. Turn off power to the unit.
3. Press and hold the **NO** key on the keypad.
4. Turn on power to the controller still holding the **NO** key.
5. When prompted `RESET WITH DEFAULTS?`, release the **NO** key and press the **YES** key.
6. If you do not see the `RESET WITH DEFAULTS?` prompt or do not get a chance to press **YES**, repeat the procedure.
7. Restore the controller settings.

If you have a stand-alone system, there is no way to recover your original parameters. If you have a computer-supervised system with AnaWin or Anasoft, a copy of your parameters can be saved to a job file.

Replacing the EPROM

Replacing the EPROM involves minor mechanical disassembly and reassembly of the controller. You will need a Phillips screwdriver and a small flathead screwdriver.

CAUTION! ***The EPROM and other components are sensitive to damage from electrostatic discharge (ESD). To prevent ESD damage, use an ESD wrist strap or other antistatic device.***

NOTE! ***Replacing the EPROM with another version results in full erasure of RAM. Make a record of all parameters before changing the EPROM.***

1. Make a record of system parameters.
2. Power down the controller.
3. Remove the four screws from the sides of the controller front panel.
4. Remove the electronics assembly from the case, as shown in *Figure 9.1*.

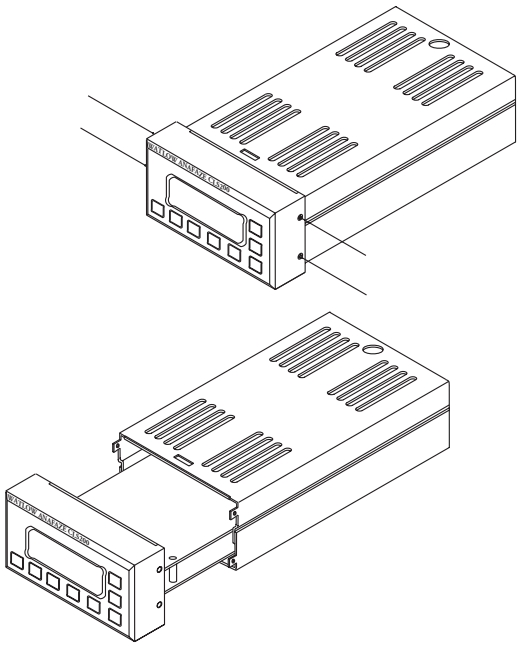


Figure 9.1 Removal of Electronics Assembly from Case

5. Unscrew the four screws at the corners of the top board and carefully unplug this board to access the bottom board (processor board). *Figure 9.2* shows the screws to remove:

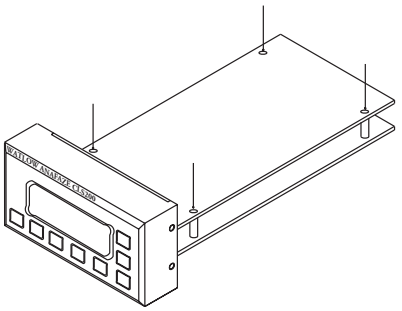


Figure 9.2 Screws Locations on PC Board

6. Locate the EPROM on the circuit board. The EPROM is a 32-pin socketed chip that is labeled with the model, version and checksum.

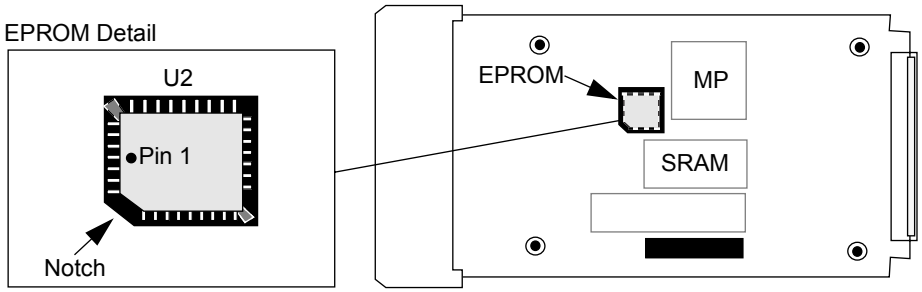


Figure 9.3 EPROM Location

7. Remove the existing EPROM from its socket with an IC extraction tool or a jeweler's flathead screwdriver.

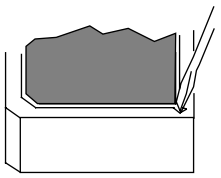


Figure 9.4 Remove EPROM

8. Carefully insert the new EPROM into the EPROM socket. Make sure that the chip is oriented so that its notch fits in the corresponding corner of the socket.
9. Reverse steps 2 through 4 to reassemble the unit.
10. Power up the controller.
11. Re-enter parameters.

Changing Communications

To switch between EIA/TIA-232 and EIA/TIA-485, change the jumpers as shown in *Figure 9.5*.

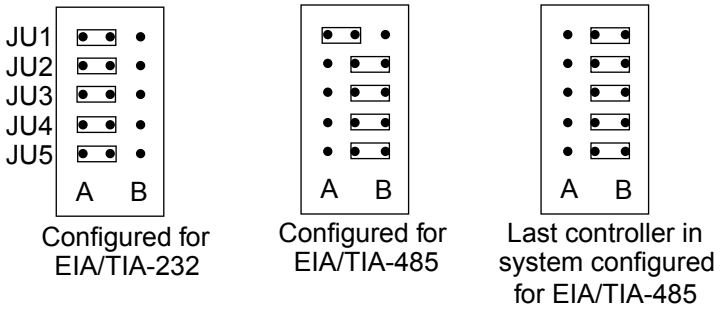


Figure 9.5 Jumper Configurations

You will need tweezers and a Phillips head screwdriver to switch between EIA/TIA-232 and EIA/TIA-485. Follow these steps:

1. Power down the unit.
2. Remove the controller's metal casing. See *Replacing the EPROM on page 176* for step-by-step instructions.
3. Find jumpers JU2, JU3, JU4, and JU5 on the board.
4. Use tweezers to carefully grasp the jumpers and gently slide them off the pins.
5. Use tweezers to gently slide jumpers JU2, JU3, JU4 and JU5 onto the correct pins (see *Figure 9.5*).
6. If you are configuring the controller as the last device on an EIA/TIA-485 network, move JU1 to the B position.
7. Reassemble the controller.

Installing Scaling Resistors

Resistors are installed for all inputs on the CLS200. Inputs with signal ranges between -10 and +60 mV use 0 Ω resistors in the RC position only. All other input signals require special input scaling resistors.

CAUTION! ***Scaling resistors are soldered to the circuit board. Only qualified technicians should attempt to install or remove these components. Improper techniques, tools or materials can result in damage to the controller that is not covered by the warranty.***

CLS204 and CLS208 Input Circuit

The CLS204 and CLS208 can accept differential thermocouple, mV⎓ (dc), V⎓ (dc), mA⎓ (dc) and RTD inputs. Unless ordered with special inputs these controller accept only signals within the standard range -10 to 60mV⎓ (dc).

To accommodate other signals, the input circuit must be modified. When configured for thermocouple inputs, 0 Ω resistors are installed in all RC locations. To accommodate voltage signals outside the standard range, milliamp current signals or RTDs, resistors are added or replaced to scale the signals to the standard range. These resistor can be installed by Watlow Anafaze or by a qualified electronics technician using scaling resistors supplied by Watlow Anafaze.

Figure 9.6 shows the input circuit for one differential, analog input. See *CLS204 and CLS208 Current Inputs on page 181* through *CLS204 and CLS208 RTDs and Thermistors on page 183* for specific instructions and resistor values for voltage, current and RTD inputs.

NOTE! ***When adding your own scaling resistors to the controller, for voltage and RTD inputs you will have to carefully remove one of the RC resistors in order to install the resistor listed in the table.***

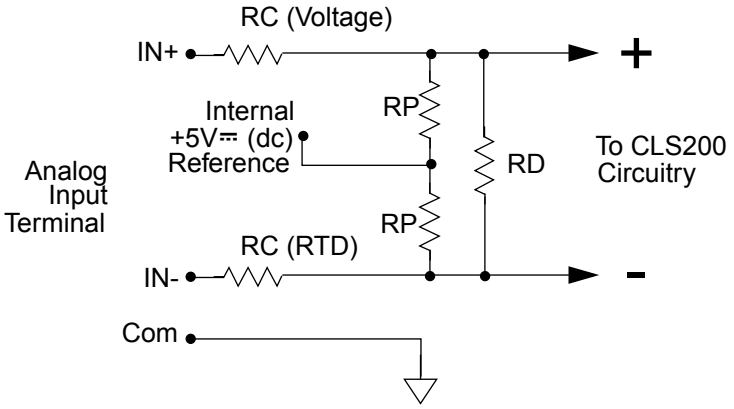


Figure 9.6 CLS204 and CLS208 Input Circuit

CLS204 and CLS208 Current Inputs

For each current input on a CLS204 or CLS208 controller you must install a resistor. The value of the resistor must be correct for the expected input range. Install the resistor in the listed resistor pack (RP) location. Note the resistor pack locations have three through holes. Install the resistor as shown in the illustration below.

Table 9.6 Resistor Values for CLS204 and CLS208 Current Inputs

Input Range	Resistor Value RD
0 to 10 mA	6.0 Ω
0 to 20 mA	3.0 Ω

Resistor tolerance: ±0.1%

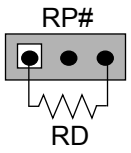


Table 9.7 Resistor Locations for CLS204 and CLS208 Current Inputs

Loop	Resistor Location RD	Loop	Resistor Location RD
1	RP1	5	RP5
2	RP2	6	RP6
3	RP3	7	RP7
4	RP4	8	RP8

CLS204 and CLS208 Voltage Inputs

For each voltage input on a CLS204 and CLS208 controller you must install two resistors. The resistances must be correct for the expected input range. Note the resistor pack (RP) locations have three through holes. Install the RD resistor as indicated in the illustration below.

Table 9.8 Resistor Values for CLS204 and CLS208 Voltage Inputs

	Resistor Values	
Input Range	**RC**	**RD**
0 to100mV⎓ (dc)	499 Ω	750 Ω
0 to 500mV⎓ (dc)	5.49 kΩ	750 Ω
0 to 1V⎓ (dc)	6.91 kΩ	442.0 Ω
0 to 5V⎓ (dc)	39.2 kΩ	475.0 Ω
0 to 10V⎓ (dc)	49.9 kΩ	301.0 Ω
0 to 12V⎓ (dc)	84.5 kΩ	422.0 Ω

Resistor tolerance: ±0.1%

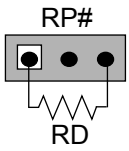


Table 9.9 Resistor Locations for CLS204 and CLS208 Voltage Inputs

	Resistor Locations	
Loop	**RC**	**RD**
1	R58	RP1
2	R56	RP2
3	R54	RP3
4	R52	RP4
5	R50	RP5
6	R48	RP6
7	R46	RP7
8	R44	RP8

CLS204 and CLS208 RTDs and Thermistors

For each RTD or thermistor input on a CLS204 or CLS208 controller, you must install three resistors: RA, RB, and RC. The resistance must be correct for the expected input range. RA and RB are a matched pair of resistors. Install them in the resistor pack (RP) locations as shown in the illustration below.

Table 9.10 Resistor Values for CLS204/208 RTD and Thermistor Inputs

	Resistor Values	
Input	**RA/RB**	**RC**
RTD1	10.0 kΩ	80 Ω
RTD2	25.0 kΩ	100 Ω

Resistor tolerances: RA/RB matched to 0.02% (2 ppm/°C) and absolute tolerance is 0.1% (10 ppm/°C) RC accurate to 0.05%.

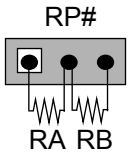


Table 9.11 Resistor Locations for CLS204/208 RTD and Thermistor Inputs

	Resistor Locations	
Loop	**RA/RB**	**RC**
1	RP1	R57
2	RP2	R55
3	RP3	R53
4	RP4	R51
5	RP5	R49
6	RP6	R47
7	RP7	R45
8	RP8	R43

CLS216 Input Circuit

The CLS216 can accept single-ended thermocouple, mV⎓ (dc), V⎓ (dc) and mA⎓ (dc) inputs. Unless ordered with special inputs, the controller accepts only signals within the standard range of -10 to 60mV⎓ (dc).

To accommodate other signals, the input circuit must be modified. When configured for thermocouple inputs, 0 Ω resistors are installed in all RC locations. To accommodate milliamp current signals or voltage signals outside the standard range, resistors are added or replaced to scale the signals to the standard range. These resistors can be installed by Watlow Anafaze or by a qualified electronics technician using scaling resistors supplied by Watlow Anafaze.

Figure 9.7 shows the schematic for one single-ended sensor input to the CLS216. See *CLS216 Current Inputs on page 184* and *CLS216 Voltage Inputs on page 185* for specific instructions and resistor values for voltage and current inputs.

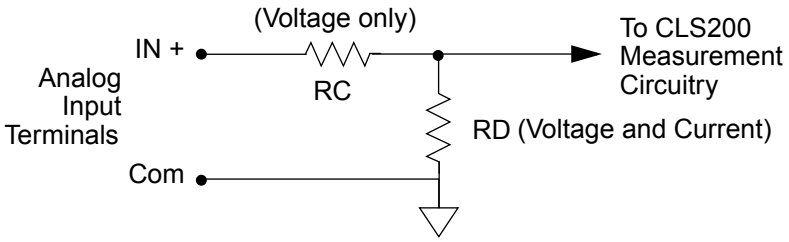


Figure 9.7 CLS216 Input Circuit

CLS216 Current Inputs

For each current input on a CLS216 controller, you must install one resistor. The value of the resistor must be correct for the expected input range. Install the resistor in the listed resistor location.

Table 9.12 Resistor Values for CLS216 Current Inputs

Input Range	Resistor Value RD
0 to 10 mA	6.0 Ω
0 to 20 mA	3.0 Ω

Resistor tolerance: ±0.1%

Table 9.13 Resistor Locations for CLS216 Current Inputs

Loop	Resistor Location RD	Loop	Resistor Location RD
1	R42	9	R41
2	R40	10	R39
3	R38	11	R37
4	R36	12	R35
5	R34	13	R33
6	R32	14	R31
7	R30	15	R29
8	R28	16	R27

CLS216 Voltage Inputs

For each voltage input on a CLS216 controller, you must install two resistors. The resistance must be correct for the expected input range. Install the resistors in the listed locations.

Table 9.14 Resistor Values for CLS216 Voltage Inputs

	Resistor Values	
Input Range	**RC**	**RD**
0 to 100mV⎓ (dc)	499 Ω	750 Ω
0 to 500mV⎓ (dc)	5.49 kΩ	750 Ω
0 to 1V⎓ (dc)	6.91 kΩ	442.0 Ω
0 to 5V⎓ (dc)	39.2 kΩ	475.0 Ω
0 to 10V⎓ (dc)	49.9 kΩ	301.0 Ω
0 to 12V⎓ (dc)	84.5 kΩ	422.0 Ω

Resistor tolerance: ±0.1%

Table 9.15 Resistor Locations for CLS216 Voltage Inputs

	Resistor Locations	
Loop	**RC**	**RD**
1	R58	R42
2	R56	R40
3	R54	R38
4	R52	R36
5	R50	R34
6	R48	R32
7	R46	R30
8	R44	R28

	Resistor Locations	
Loop	**RC**	**RD**
9	R57	R41
10	R55	R39
11	R53	R37
12	R51	R35
13	R49	R33
14	R47	R31
15	R45	R29
16	R43	R27

Scaling and Calibration

The controller provides offset calibration for thermocouple, RTD, and other fixed ranges, and offset and span (gain) calibration for linear and pulse inputs. In order to scale linear input signals, you must:

1. Install appropriate scaling resistors. (Contact Watlow Anafaze's Customer Service Department for more information about installing scaling resistors.)
2. Select the display format. The smallest possible range is -.9999 to +3.0000; the largest possible range is -9,999 to 30,000.
3. Enter the appropriate scaling values for your process.

Configuring Dual DAC Outputs

Dual DAC modules ship with both outputs configured for the signal type and span ordered. The module contains two independent circuits (DAC1 and DAC2). These circuits can be configured for different output types. Remove the board from the housing and set the jumpers. The odd numbered jumpers determine the signal from DAC1; the even numbered jumpers determine the output from DAC2.

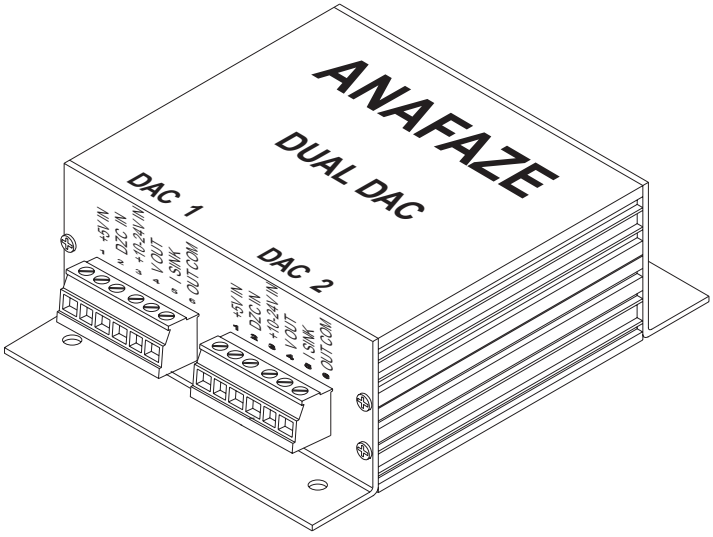


Figure 9.8 Dual DAC

Table 9.16 Dual DAC Jumper Settings

Output Type	Jumper Settings						
	1/2	3/4	5/6	7/8	9/10	11/12	13/14
0 to 5V⎓ (dc)	B	A	A	O	B	A	O
0 to 10V⎓ (dc)	B	A	A	O	B	O	O
4 to 20 mA	O	A	B	A	A	O	A

A = Load jumper in the "A" position, or load jumper if header has only two pins.

B = Load jumper in the "B" position.

O = Open. Do not load jumper.

1. Power down the system (if the Dual DAC is already installed and wired).
2. Ensure the DAC1 and DAC2 terminal blocks or associated wires are labeled such that you will know which terminal block connects to which side of the board if the module is already installed and wired.
3. Unplug the two terminal blocks.
4. Depending on the installation, you may need to unmount the Dual DAC module before proceeding. Remove the four screws from the end plate on the opposite side of the module from the terminal blocks.

5. If necessary, remove the two mounting screws holding the loosened end plate in place.
6. Slide the board out of the housing.
7. Set the jumpers for the two outputs as desired. See *Table 9.16*.
8. Replace the board such that the connectors extend through the opposite end plate. The board fits in the third slot from the bottom.
9. Reconnect the two terminal blocks to the DAC1 and DAC2 connectors.
10. Replace the end plate, end plate screws and, if necessary, mounting screws.
11. Check the wire connections to the DAC1 and DAC2 terminal blocks.
12. If necessary, change the wiring connections to the correct configuration for the new output type. See *Wiring the Dual DAC on page 43*.
13. Restore system power.

Configuring Serial DAC Outputs

The Serial DAC's voltage and current output is jumper selectable. Refer to *Figure 9.9*. Configure the jumpers as indicated on the Serial DAC label.

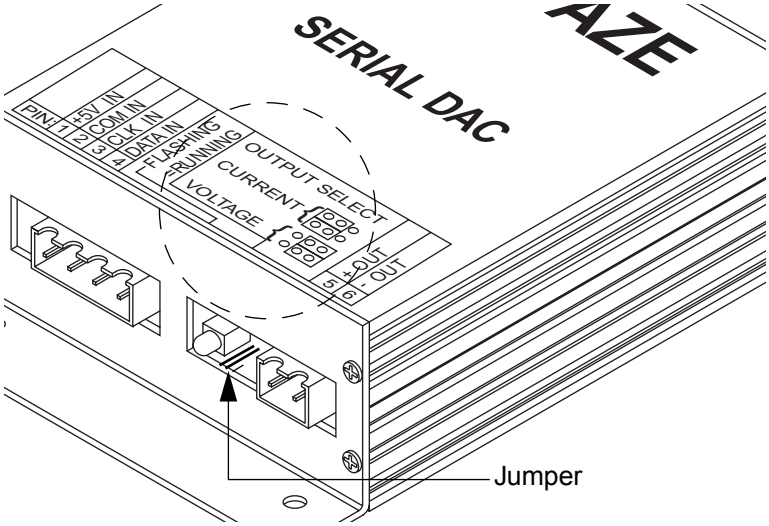


Figure 9.9 Serial DAC Voltage/Current Jumper Positions

10

Linear Scaling Examples

This chapter provides three linear scaling examples. The examples describe:

- A pressure sensor generating a 4 to 20 mA signal
- A flow sensor generating a 0 to 5V signal
- A pulse encoder generating 900 pulses per inch of movement

Example 1: A 4-to-20 mA Sensor

Situation

A pressure sensor that generates a 4 to 20 mA signal is connected to the controller. The specifications of the sensor state it generates 4 mA at 0.0 pounds per square inch (PSI) and 20 mA at 50.0 PSI.

Setup

The sensor is connected to a loop input set up with a resistor scaling network producing 60mV at 20 mA.

The `INPUT TYPE` for the loop is set to `LINEAR`. The sensor measures PSI in tenths, so the `DISP FORMAT` is set to `-999.9 TO +3000.0`.

Table 10.1 Input Readings

Process Variable Displayed	Sensor Input	Reading, Percent of Full Scale (%FS)
50.0 PSI	20 mA	100%FS
0.0 PSI	4 mA	100% x (4 mA/20 mA) = 20%FS

The scaling values setup in the SETUP LOOP INPUT menu are shown in *Table 10.2* .

Table 10.2 Scaling Values

Parameter	Prompt	Value
High Process Variable	HIGH PV	50.0 PSI
High Sensor Reading	HIGH RDG	100.0%FS
Low Process Variable	LO PV	0.0 PSI
Low Sensor Reading	LO RDG	20.0%FS

Example 2: A 0-to-5V⎓ (dc) Sensor

Situation

A flow sensor connected to the controller measures the flow in a pipe. The sensor generates a 0 to 5V signal. The sensor's output depends on its installation. Independent calibration measurements of the flow in the pipe indicate that the sensor generates 0.5V at three gallons per minute (GPM) and 4.75V at 65 GPM. The calibration instruments are accurate to within 1 gallon per minute.

Setup

The sensor is connected to a loop input set up with a resistor voltage divider network producing 60mV at 5V.

The INPUT TYPE for the loop is set to LINEAR. The calibrating instrument is precise to ±1 GPM, so the DISP FORMAT is set to -999 to +3000.

This table shows the input readings and the percentage calculation from the 60mV full scale input.

Table 10.3 Input Readings and Calculations

Process Variable Displayed	Sensor Input	Reading, Percent of Full Scale (%FS)
65 GPM	4.75	(4.75V / 5.00V) x 100%=95%FS
3 GPM	0.5	(0.5V / 5.00V) x 100%=10%FS

Table 10.4 Scaling Values

Parameter	Prompt	Value
High Process Variable	HIGH PV	65 GPM
High Sensor Reading	HIGH RDG	95.0%FS
Low Process Variable	LO PV	0.0 GPM
Low Sensor Reading	LO RDG	10.0%FS

Example 3: A Pulse Encoder

Situation

A pulse encoder which measures the movement of a conveyor is connected to the controller. The encoder generates 900 pulses for every inch the conveyor moves. You want to measure conveyor speed in feet per minute (FPM).

Setup

The encoder input is connected to the controller's pulse input. The INPUT TYPE for the loop is set to PULSE. A one-second sample time gives adequate resolution of the conveyor's speed. The resolution is:

$$\frac{1 \text{ pulse}}{1 \text{ second}} \times \frac{60 \text{ seconds}}{1 \text{ minute}} \times \frac{1 \text{ inch}}{900 \text{ pulses}} \times \frac{1 \text{ foot}}{12 \text{ inches}} = 0.006 \text{ FPM}$$

A DISP FORMAT of -99.99 TO +300.00 is appropriate.

The input readings are as follows:

- At 0 Hz, the input reading will be 0.00 FPM.
- At the maximum pulse rate of the CLS200 (2000 Hz):

$$\frac{2000 \text{ pulses}}{1 \text{ second}} \times \frac{60 \text{ seconds}}{1 \text{ minute}} \times \frac{1 \text{ inch}}{900 \text{ pulses}} \times \frac{1 \text{ foot}}{12 \text{ inches}} = 11.11 \text{ FPM}$$

Table 10.5 Scaling Values

Parameter	Prompt	Value
High Process Variable	HIGH PV	11.11 FPM
High Sensor Reading	HIGH RDG	2000 Hz
Low Process Variable	LO PV	0 FPM
Low Sensor Reading	LO RDG	0 Hz

11

Specifications

This chapter contains specifications for the CLS200 series controllers, TB50 terminal board, Dual DAC module, Serial DAC module and the CLS200 power supply.

CLS200 System Specifications

This section contains CLS200 series controller specifications for environmental specifications and physical dimensions, inputs, outputs, the serial interface and system power requirements.

The controller described consists of a processor module and a 50-terminal block (TB50).

Table 11.1 Agency Approvals / Compliance

CE Directive	Electromagnetic Compatibility (EMC) Directive 89/336/EEC
UL and C-UL	UL 916, Standard for Energy Management Equipment File E177240

CLS200 Processor Physical Specifications

Table 11.2 Environmental Specifications

Storage Temperature	-20 to 60° C
Operating Temperature	0 to 50° C
Humidity	10 to 95% non-condensing
Environment	The controller is for indoor use only

Table 11.3 Physical Dimensions

Weight	1.98 lbs	0.9 kg
Length*	8.0 inches	203 mm
Width	3.78 inches	96 mm
Height	1.96 inches	50 mm

* Without SCSI connector or with TB18 option.

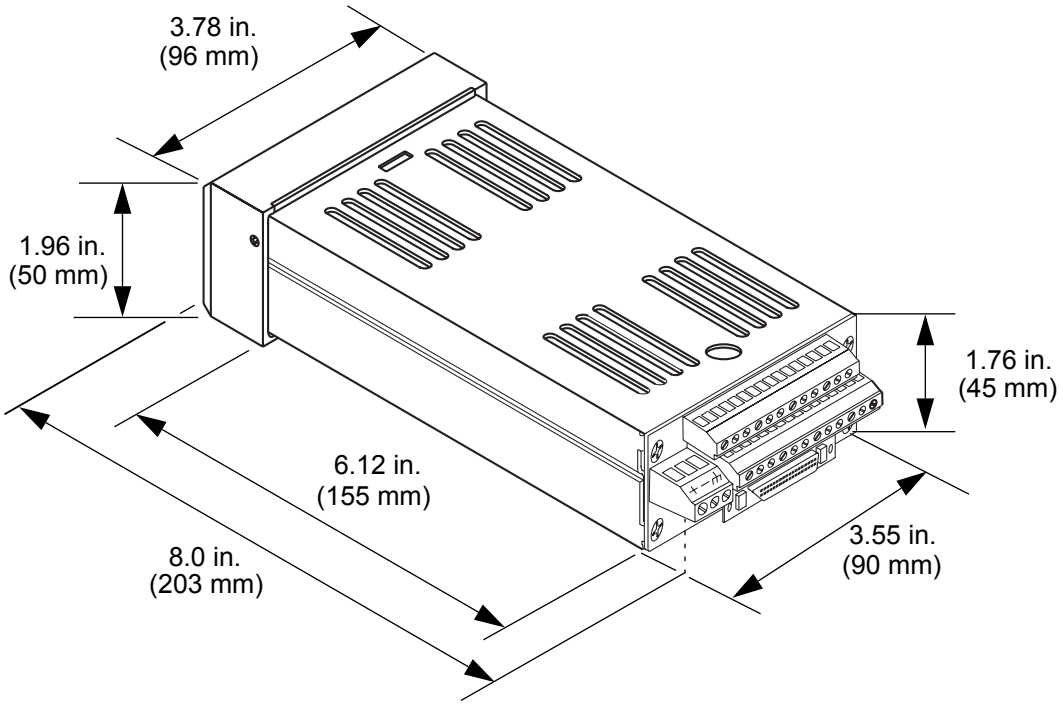


Figure 11.1 CLS200 Processor Module Dimensions

Table 11.4 Processor with Straight SCSI

Length	9.6 inches	244 mm
Width	3.78 inches	96 mm
Height	1.96 inches	50 mm

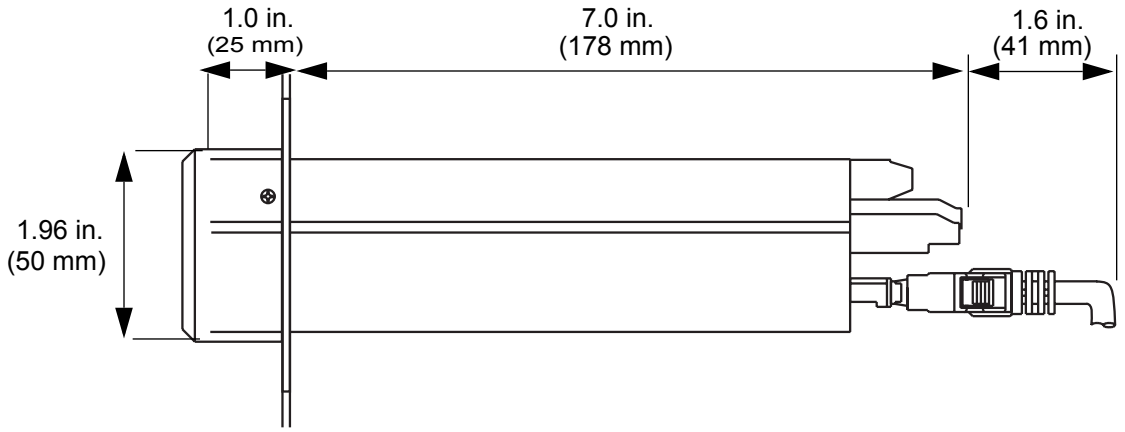


Figure 11.2 CLS200 Clearances with Straight SCSI Cable

Table 11.5 Processor with Right Angle SCSI

Length	8.6 inches	218 mm
Width	3.78 inches	96 mm
Height	1.96 inches	50 mm

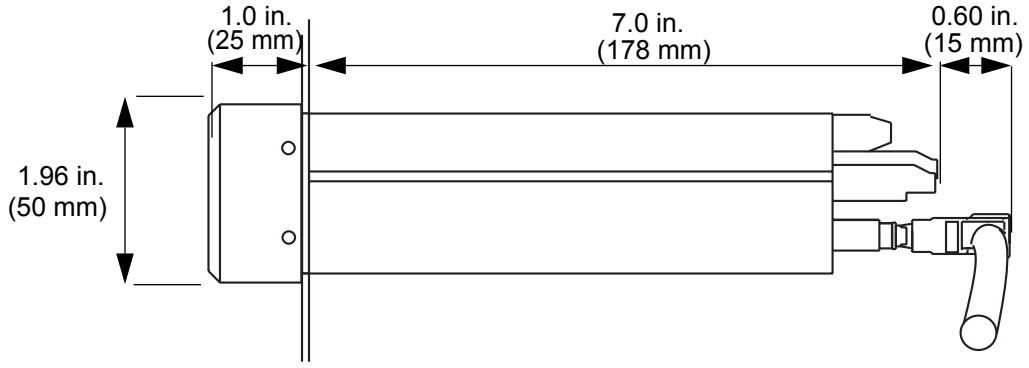


Figure 11.3 CLS200 Clearances with Right-Angle SCSI Cable

Table 11.6 Processor Connections

Power Terminals (TB2)	Captive screw cage clamp
Power Wire Gauge (TB2)	22 to 18 AWG (0.5 to 0.75 mm^2)
Power Terminal Torque (TB2)	4.4 to 5.3 in-lb. (0.5 to 0.6 Nm)
Sensor Terminals (TB1)	Captive screw cage clamp
Sensor Wire Gauge (TB1)	Thermocouples: 20 AWG (0.5 mm^2) Linear: 22 to 20 AWG (0.5 mm^2) Communications: 24 AWG (0.2 mm^2)
Sensor Terminal Torque (TB1)	4.4 to 5.3 in-lb. (0.5 to 0.6 Nm)
Output Terminals (TB18)	Captive screw cage clamp
Output Wire Gauge (TB18)	Multiconductor cables: 24 AWG (0.2 mm^2) Single-wire: 22 to 18 AWG (0.5 to 0.75 mm^2)
Output Terminal Torque (TB18)	4.4 to 5.3 in-lb. (0.5 to 0.6 Nm)
SCSI Connector	SCSI-2 female

TB50 Physical Specifications

Table 11.7 TB50 Physical Dimensions

Weight	0.32 lb.	0.15 kg
Length	4.1 inches	104 mm
Width	4.0 inches	102 mm
Height	1.5 inches	37 mm

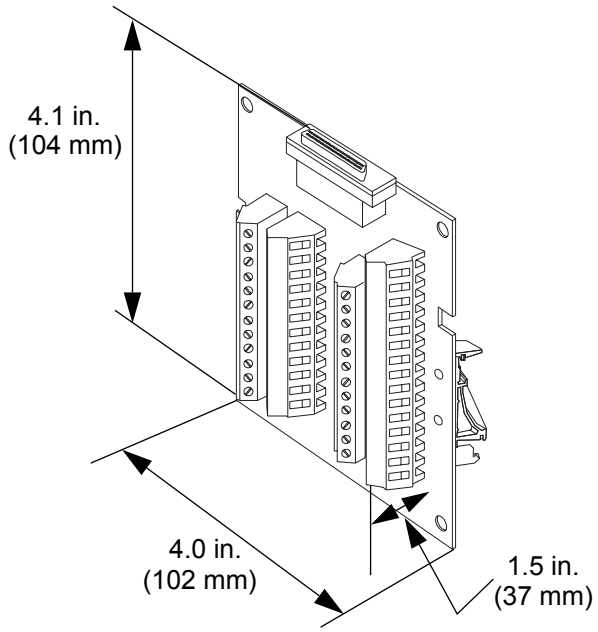


Figure 11.4 TB50 Dimensions

Table 11.8 TB50 Connections

Screw Terminal Torque	4.4 to 5.3 in-lb. (0.5 to 0.6 Nm)
SCSI Connector on Board	SCSI-2 female
Output Terminals	Captive screw cage clamp
Output Wire Gauge	Multiconductor cables: 24 AWG (0.2 mm^2) Single-wire: 22 to 18 AWG (0.5 to 0.75 mm^2)
Output Terminal Torque	4.4 to 5.3 in-lb. (0.5 to 0.6 Nm)

Table 11.9 TB50 with Straight SCSI

Length	6.4 inches	163 mm
Width	4.0 inches	102 mm
Height	1.5 inches	37 mm

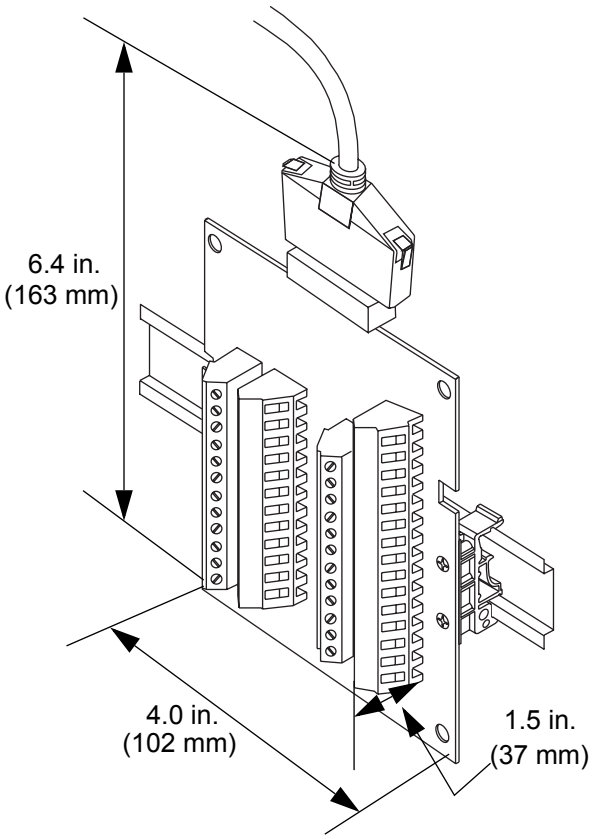


Figure 11.5 TB50 Dimensions with Straight SCSI Cable

Table 11.10 TB50 with Right Angle SCSI

Length	5.4 inches	137 mm
Width	4.0 inches	102 mm
Height	1.5 inches	37 mm

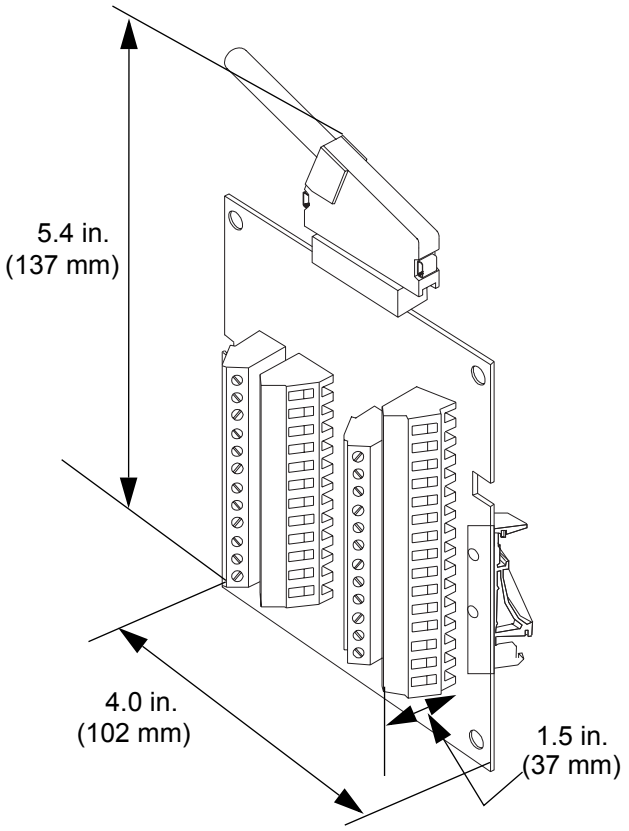


Figure 11.6 TB50 Dimensions with Right-Angle SCSI Cable

Inputs

The controller accepts analog sensor inputs which are measured and may be used as feedback for control loops. It also accepts digital (TTL) inputs which may be used to trigger certain firmware features.

Table 11.11 Analog Inputs

Parameter	Description
Number of Control Loops	CLS204: 5; CLS208: 9; CLS216: 17
Number of Analog Inputs	CLS204: 4 with full range of input types, plus one pulse CLS208: 8 with full range of input types, plus one pulse CLS216: 16 with full range of input types, plus one pulse
Input Switching	CLS204 and CLS208: Differential solid state multiplexer CLS216: Single-ended, solid state multiplexer
Input Sampling Rate	CLS204: 6 Hz (167 ms) at 60 Hz; 5 Hz (200 ms) at 50 Hz. CLS208: 3 Hz (333 ms) at 60 Hz; 2.5 Hz (400 ms) at 50 Hz. CLS216:1.5 Hz (667 ms) at 60 Hz; 1.25 Hz (800 ms) at 50 Hz
Analog Over Voltage Protection	±20V referenced to digital ground.
Maximum Common Mode Voltage	5V input to input or input to analog common (CLS204 and CLS208)
Common Mode Rejection (CMR)	For inputs that do not exceed ±5V, >60 dB dc to 1 kHz, and 120 dB at selected line frequency.
A/D Converter	Integrates voltage to frequency
Input Range	-10 to +60mV, or 0 to 25V with scaling resistors
Resolution	0.006%, greater than 14 bits (internal)
Accuracy	0.03% of full scale (60mV) at 25° C
	0.08% of full scale (60mV) at 0 to 50° C
Calibration	Automatic zero and full scale
DC Common to Frame Ground Maximum Potential	20V
Thermocouple Break Detection	Pulse type for upscale break detection
Milliampere Inputs	0 to 20 mA (3 Ω resistance) or 0 to 10 mA (6 Ω resistance), with scaling resistors
Linear Voltage Input Ranges Available	0 to12V, 0 to 10V, 0 to 5V, 0 to 1V, 0 to 500 mV, 0 to 100 mV with scaling resistors.
Source Impedance	For 60mV thermocouple, measurements are within specifica tion with up to 500 Ω source resistance For other types of analog signals, the maximum source impedance is 5,000 Ω

Table 11.12 Pulse Inputs

Parameter	Description
Number	1
Frequency Range	0 to 2,000 Hz
Input Voltage Protection	Diodes to supply and common
Voltage Levels	<1.3V: Low >3.7V: High (TTL)
Maximum Switch Resistance to Pull Input Low	2 kΩ
Minimum Switch Off Resistance	30 kΩ

Table 11.13 Thermocouple Range and Resolution

Thermocouple Type	Range in °F	Range in °C	Accuracy* at 25°C Ambient		Accuracy* at 0 to 50°C Ambient	
			°F	°C	°F	°C
J	-350 to 1,400	-212 to 760	±2.2	±1.2	±3.3	±1.8
K	-450 to 2,500	-268 to 1371	±2.4	±1.3	±3.8	±2.1
T	-450 to 750	-268 to 399	±2.9	±1.6	±5.8	±3.2
S	0 to 3,200	-18 to 1,760	±5.0	±2.8	±8.8	±4.9
R	0 to 3,210	-18 to 1,766	±5.0	±2.8	±8.8	±4.9
B	150 to 3,200	66 to 1,760	±7.2	±4.0	±22.1	±12.3
E	-328 to 1,448	-200 to 787	±1.8	±1.0	±2.9	±1.6

* True for 10% to 100% of span except type B, which is specified for 800° F to 3200° F.

Table 11.14 RTD Range and Resolution

Name	Range in °F	Range in °C	Resolution in °C	Measurement Temperature in °C	Accuracy at 25°C Ambient		Accuracy at 0 to 50°C Ambient	
					°F	°C	°F	°C
RTD1	-148.0 to 527.0	-100.0 to 275.0	0.023	25	±0.7	±0.4	±1.0	±0.6
				275	±1.9	±1.1	±2.8	±1.6
RTD2	-184 to 1544	-120 to 840	0.023	25	±2.5	±1.4	±5.9	±3.3
				840	±2.9	±1.6	±8.6	±4.8

Table 11.15 Input Resistance for Voltage Inputs

Range	Input Resistance
0 to 12V	85 kΩ
0 to 10V	50 kΩ
0 to 5V	40 kΩ
0 to 1V	7.4 kΩ
0 to 500mV	6.2 kΩ
0 to 100mV	1.2 kΩ

Table 11.16 Digital Inputs

Parameter	Description
Number	8
Configu ation	8 selectable for output override, remote job selection
Input Voltage Protection	Diodes to supply and common. Source must limit current to 10 mA for override conditions
Voltage Levels	<1.3V: Low >3.7V: High (TTL) 5V maximum, 0V minimum
Maximum Switch Resistance to Pull Input Low	1 kΩ
Minimum Switch Off Resistance	11 kΩ
Update Rate	6 Hz

Outputs

The controller directly accommodates switched dc and open-collector outputs only. These outputs can be used to control a wide variety of loads. They are typically used to control SSRs or other power switching devices which in turn control, for example, heaters. They may also be used to signal another device of an alarm condition in the controller.

Analog outputs may be accomplished by using Dual DAC or Serial DAC modules in conjunction with one of the control outputs.

An open-collector CPU watchdog output is also provided so that an external device may monitor the CPU state.

Analog Outputs

No direct analog outputs are provided.

The digital outputs may be used in conjunction with Dual DAC or Serial DAC modules to provide analog signals. See *Dual DAC Specifications on page 207* and *Serial DAC Specifications on page 209*.

Digital Outputs

Table 11.17 Digital Outputs Control / Alarm

Parameter	Description
Number	35
Operation	Open collector output; ON state sinks to logic common
Function	34 Outputs selectable as closed-loop control or alarm/control. 1 global alarm output
Number of Control Outputs per PID Loop	2 (maximum)
Control Output Types	Time proportioning, distributed zero crossing, Serial DAC or on/off. All independently selectable for each output. Heat and cool control outputs can be individually disabled for use as alarm outputs
Time Proportioning Cycle Time	1 to 255 seconds, programmable for each output
Control Action	Reverse (heat) or direct (cool), independently selectable for each output
Off State Leakage Current	<0.01 mA to dc common
Maximum Current	60 mA for each output. 5V power supply (from the processor module) can supply up to 350 mA total to all outputs
Maximum Voltage Switched	24V⎓ (dc)

Table 11.18 CPU Watchdog Output

Parameter	Description
Number	1
Operation	Open collector output; ON state sinks to logic common
Function	Monitors the processor module microprocessor
Maximum Current	10 mA (5V power supply in the processor module can supply up to 350 mA total to all outputs)
Maximum Voltage Switched	5V⎓ (dc)

Table 11.19 5V⎓ (dc) Output (Power to Operate Solid-State Relays)

Parameter	Description
Voltage	5V⎓ (dc)
Maximum Current	350 mA

Table 11.20 Reference Voltage Output (Power to Operate Bridge Circuit Sensors)

Parameter	Description
Voltage	5V⎓ (dc)
Maximum Current	100 mA

Table 11.21 Processor Serial Interface

Parameter	Description
Type	EIA/TIA-232 3-wire or EIA/TIA-485 4-wire
Isolation	None
Baud Rate	2,400, 9,600 or 19,200 user selectable
Error Check	BCC or CRC, user selectable
Number of Controllers	1 with EIA/TIA-232 communications; up to 32 with EIA/TIA-485 communications, depending upon protocol
Protocol	Form of ANSI X3.28-1976 (D1, F1), compatible with Allen Bradley PLC, full duplex or Modbus RTU

Table 11.22 Processor Power Requirements

Parameter	Description
Voltage	15 to 24V⎓ (dc) +/- 3V⎓ (dc)
Maximum Current	1 A

CLS200 Power Supply

Complete specifications for the CLS200 power supply are available at www.watlow.com. See the links on the CLS200 page.

Dual DAC Specifications

The Watlow Anafaze Dual DAC (digital-to-analog converter) is an optional module for the CLS200 series controller. The Dual DAC converts a distributed zero crossing (DZC) output signal to an analog process control signal. Watlow Anafaze provides the following version of the Dual DAC:

- 4 to 20 mA dc
- 0 to 5V⎓ (dc)
- 0 to 10V⎓ (dc)

Table 11.29 Dual DAC Environmental Specifications

Storage Temperature	-20 to 60° C
Operating Temperature	0 to 50° C
Humidity	10 to 95% non-condensing

Table 11.30 Dual DAC Physical Specifications

Weight	0.42 lb.	0.19 kg
Length	4.4 inches	112 mm
Width	3.6 inches	91 mm
Height	1.8 inches	44 mm

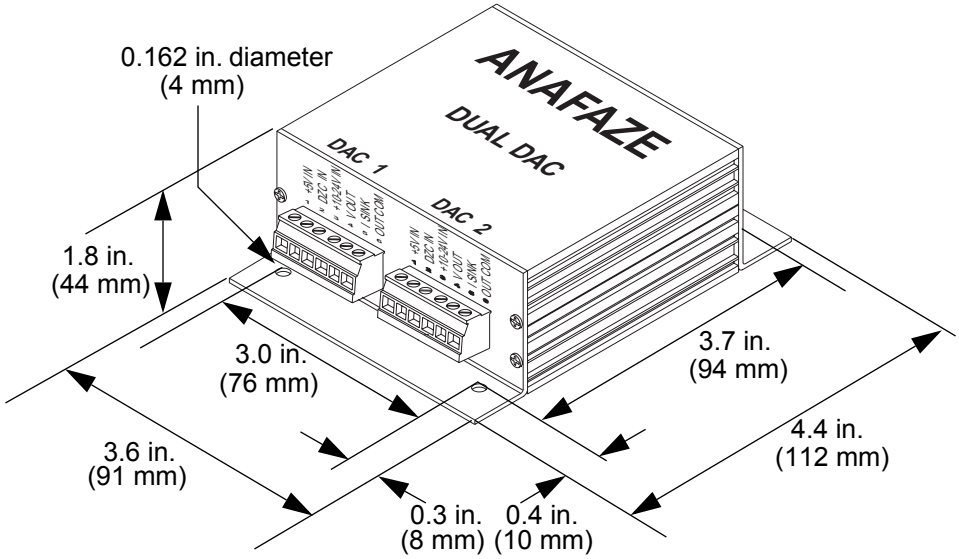


Figure 11.8 Dual DAC Dimensions

Dual DAC Inputs

The Dual DAC accepts an open-collector signal from the CLS200 controller and the power from an external power supply. See *Table 11.31*.

Table 11.31 Dual DAC Power Requirements

Parameter	Description
Voltage	12 to 24V⎓ (dc)
Current	100 mA @ 15V⎓ (dc)

Dual DAC Analog Outputs

Table 11.32 Dual DAC Specifications by Output Range

Version	4-20 mA	0-5 V	0-10 V	Units
Gain Accuracy	± 6	± 6	±	6 %
Output Offset	± 0.75	± 0.75	± 0.75	% of full scale range
Ripple	1.6	1.6	1.6	% of full scale range
Time Constant	2	2	2	seconds
Maximum Current Output	20	10	10	mA dc
Load Resistance (12V)	250 maximum	500 minimum	1000 minimum	Ω
Load Resistance (24V)	850 maximum	n/a	n/a	Ω

Serial DAC Specifications

Watlow Anafaze offers a Serial DAC for precision open-loop analog outputs. The Serial DAC is jumper-selectable for a 0 to 10V⎓ (dc) or 4 to 20 mA output. Multiple Serial DAC modules can be used with one CLS200. The Serial DAC carries a CE mark.

Table 11.33 Serial DAC Environmental Specifications

Storage Temperature	-20 to 60° C
Operating Temperature	0 to 70° C
Humidity	10 to 95% non-condensing

Table 11.34 Serial DAC Physical Specifications

Weight	0.76 lb.	0.34 kg
Length	5.4 inches	137 mm
Width	3.6 inches	91 mm
Height	1.8 inches	44 mm

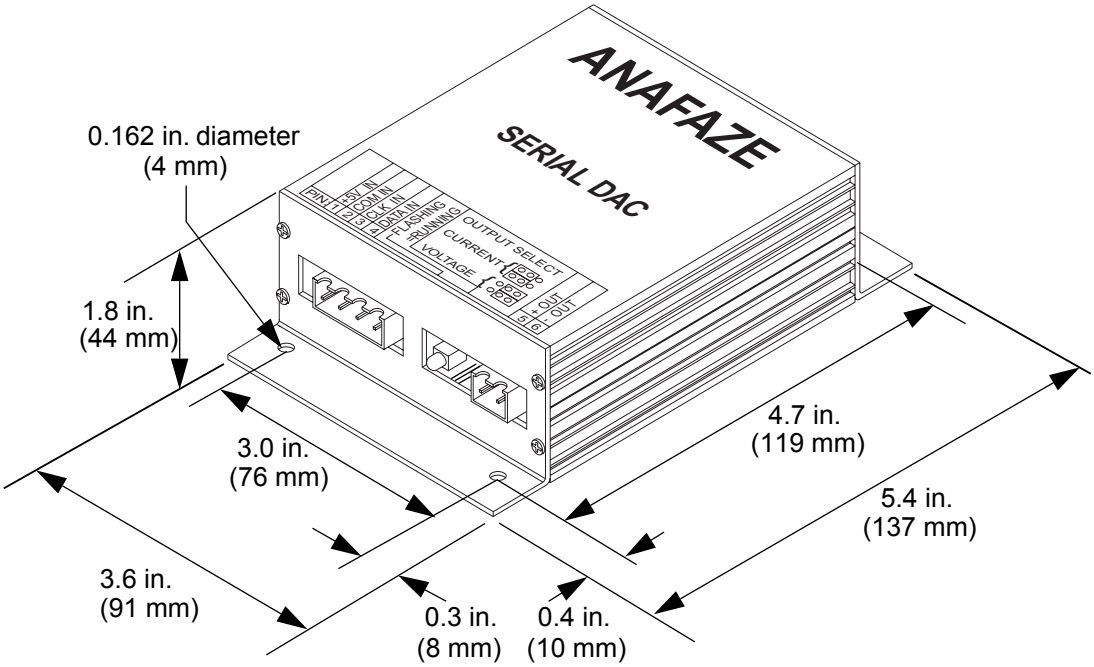


Figure 11.9 Serial DAC Dimensions

Table 11.35 Serial DAC Agency Approvals / Compliance

CE Directive	Electromagnetic Compatibility (EMC) directive 89/336/EEC
UL and C-UL	UL 916 Standard for Energy Management Equipment File E177240

Serial DAC Inputs

The Serial DAC requires a proprietary serial data signal and the clock signal from the CLS200 via the TB50. Any control output can be configured to provide the data signal. The Serial DAC also requires a 5V⎓ (dc) power input.

Table 11.36 Serial DAC Inputs

Parameter	Description
Data	4 mA maximum to DC COM Open collector or HC CMOS logic levels
Clock	0.5 mA maximum to DC COM Open collector or HC CMOS logic levels

Table 11.37 Serial DAC Power Requirements

Parameter	Description
Voltage	4.75 to 5.25V⎓ (dc) @ 300 mA maximum
Current	210 mA typical @ 20V⎓ (dc) out

Serial DAC Analog Outputs

Table 11.38 Serial DAC Analog Output Specifications

Parameter	Description
Absolute Maximum Common Mode Voltage	Measured between output terminals and controller common: 1,000V
Resolution	15 bits (plus polarity bit for voltage outputs) (0.305mV for 10V output range) (0.00061 mA for 20 mA output range)
Accuracy (Calibrated for Voltage Output)	For voltage output: ± 0.005V (0.05% at full scale) For current output: ± 0.1 mA (0.5% at full scale)
Temperature coefficien	440 ppm/ °C typical
Isolation Breakdown Voltage	1,000V between input power and signals
Current	0 to 20 mA (500 Ω load max.)
Voltage	0 to 10V⎓ (dc) with 10 mA source capability
Output Response Time	1 ms typical
Update Rate	Once per controller A/D cycle nominal. Twice per second maximum for 60 Hz clock rate. Output changes are step changes due to the fast time constant. All Serial DAC loop outputs are updated at the same time.

Glossary

A

AC
See Alternating Current.

AC Line Frequency
The frequency of the AC power line measured in Hertz (Hz), usually 50 or 60 Hz.

Accuracy
Closeness between the value indicated by a measuring instrument and a physical constant or known standards.

Action
The response of an output when the process variable is changed. See also Direct Action, Reverse Action.

Address
A numerical identifier for a controller when used in computer communications.

Alarm
A signal that indicates that the process has exceeded or fallen below a certain range around the setpoint. For example, an alarm may indicate that a process is too hot or too cold. See also:

Deviation Alarm
Failed Sensor Alarm
Global Alarm
High Deviation Alarm
High Process Alarm
Loop Alarm
Low Deviation Alarm
Low Process Alarm

Alarm Delay
The lag time before an alarm is activated.

Alternating Current (AC)
An electric current that reverses at regular intervals, and alternates positive and negative values.

Ambient Temperature
The temperature of the air or other medium that surrounds the components of a thermal system.

American Wire Gauge (AWG)
A standard of the dimensional characteristics of wire used to conduct electrical current or signals. AWG is identical to the Brown and Sharpe (B&S) wire gauge.

Ammeter
An instrument that measures the magnitude of an electric current.

Ampere (Amp)
A unit that defines the rate of flow of electricity (current) in the circuit. Units are one coulomb (6.25 x 1018 electrons) per second.

Analog Output
A continuously variable signal that is used to represent a value, such as the process value or setpoint value. Typical hardware configurations are 0 to 20mA, 4 to 20mA or 0 to 5 V⎓ (dc).

Automatic Mode
A feature that allows the controller to set PID control outputs in response to the Process Variable (PV) and the setpoint.

Autotune
A feature that automatically sets temperature control PID values to match a particular thermal system.

AWG
See American Wire Gauge.

B

Baud Rate
The rate of information transfer in serial communications, measured in bits per second.

Block Check Character (BCC)
A serial communications error checking method. An acceptable method for most applications, BCC is the default method. See also Cyclic Redundancy Check.

Bumpless Transfer
A smooth transition from automatic (closed loop) to manual (open loop) operation. The control output does not change during the transfer.

C

Calibration
The comparison of a measuring device (an unknown) against an equal or better standard.

Celsius (Centigrade)
Formerly known as Centigrade. A temperature scale in which water freezes at 0˚C and boils at 100˚C at standard atmospheric pressure. The formula for conversion to the Fahrenheit scale: ˚F = (1.8 x ˚C) + 32.

Central Processing Unit (CPU)
The unit of a computing system that includes the circuits controlling the interpretation of instructions and their execution.

Circuit
Any closed path for electrical current. A configuration of electrically or electromagnetically-connected components or devices.

Closed Loop
A control system that uses a sensor to measure a process variable and makes decisions based on that feedback.

Cold Junction
Connection point between thermocouple metals and the electronic instrument.

Common Mode Rejection Ratio
The ability of an instrument to reject electrical noise, with relation to ground, from a common voltage. Usually expressed in decibels (dB).

Communications
The use of digital computer messages to link components. See also Serial Communications, Baud Rate.

Control Action
The response of the PID control output relative to the error between the process variable and the setpoint. For reverse action (usually heating), as the process decreases below the setpoint the output increases. For direct action (usually cooling), as the process increases above the setpoint, the output increases.

Control Status
The type of action that a controller uses. For example, on/off, time proportioning, PID, automatic or manual, and combinations of these.

Current
The rate of flow of electricity. The unit of measure is the ampere (A).
1 ampere = 1 coulomb per second.

Cycle Time
The time required for a controller to complete one on-off-on cycle. It is usually expressed in seconds.

Cyclic Redundancy Check (CRC)
An error checking method in communications. It provides a high level of data security but is more difficult to implement than Block Check Character (BCC). See also Block Check Character.

D

DAC
See Digital-to-Analog Converter.

Data Logging
A method of recording a process variable over a period of time. Used to review process performance.

DC
See Direct Current.

Deadband
The range through which a variation of the input produces no noticeable change in the output. In the deadband, specific conditions can be placed on control output actions. Operators select the deadband. It is usually above the heating proportional band and below the cooling proportional band.

Default Parameters
The programmed instructions that are permanently stored in the microprocessor software.

Derivative Control (D)
The last term in the PID algorithm. Action that anticipated the rate of change of the process, and compensates to minimize overshoot and undershoot. Derivative control is an instantaneous change of the control output in the same direction as the proportional error. This is caused by a change in the process variable (PV) that decreases over the time of the derivative (TD). The TD is in units of seconds.

Deutsche Industrial Norms (DIN)

A set of technical, scientific and dimensional standards developed in Germany. Many DIN standards have worldwide recognition.

Deviation Alarm
Warns that a process has exceeded or fallen below a certain range around the setpoint.

Digital-to-Analog Converter (DAC)
A device that converts a numerical input signal to a signal that is proportional to the input in some way.

Direct Action
An output control action in which an increase in the process variable, causes an increase in the output. Cooling applications usually use direct action.

Direct Current (DC)
An electric current that flows in one direction.

Distributed Zero Crossing (DZC)
A form of digital output control in which the output on/off state is calculated for every ac line cycle. Power is switched at the zero cross, which reduces electrical noise. See also Zero Cross.

E

Earth Ground
A metal rod, usually copper, that provides an electrical path to the earth, to prevent or reduce the risk of electrical shock.

EIA/TIA
See Serial Communications.

Electrical Noise
See Noise.

Electromagnetic Interference (EMI)
Electrical and magnetic noise imposed on a system. There are many possible causes, such as switching ac power on inside the sine wave. EMI can interfere with the operation of controls and other devices.

Electrical-Mechanical Relays
See Relay, Electromechanical.

Emissivity
The ratio of radiation emitted from a surface compared to radiation emitted from a blackbody at the same temperature.

Engineering Units
Selectable units of measure, such as degrees Celsius and Fahrenheit, pounds per square inch, newtons per meter, gallons per minute, liters per minute, cubic feet per minute or cubic meters per minute.

EPROM
Erasable Programmable, Read-Only Memory inside the controller.

Error
The difference between the correct or desired value and the actual value.

F

Fahrenheit
The temperature scale that sets the freezing point of water at 32˚ F and its boiling point at 212˚ F at standard atmospheric pressure. The formula for conversion to Celsius: ˚C = 5/9 (˚F - 32).

Failed Sensor Alarm
Warns that an input sensor no longer produces a valid signal. For example, when there are thermocouple breaks, infrared problems or resistance temperature detector (RTD) open or short failures.

Filter
Filters are used to handle various electrical noise problems.

Digital Filter (DF) — A filter that allows the response of a system when inputs change unrealistically or too fast. Equivalent to a standard resistor-capacitor (RC) filter

Digital Adaptive Filter — A filter that rejects high frequency input signal noise (noise spikes).

Heat/Cool Output Filter — A filter that slows the change in the response of the heat or cool output. The output responds to a step change by going to approximately 2/3 its final value within the numbers of scans that are set.

Frequency
The number of cycles over a specified period of

time, usually measured in cycles per second. Also referred to as Hertz (Hz). The reciprocal is called the period.

G

Gain
The amount of amplification used in an electrical circuit. Gain can also refer to the Proportional (P) mode of PID.

Global Alarm
Alarm associated with a global digital output that is cleared directly from a controller or through a user interface.

Global Digital Outputs
A pre-selected digital output for each specific alarm that alerts the operator to shut down critical processes when an alarm condition occurs.

Ground
An electrical line with the same electrical potential as the surrounding earth. Electrical systems are usually grounded to protect people and equipment from shocks due to malfunctions. Also referred to a "safety ground".

H

Hertz (Hz)
Frequency, measured in cycles per second.

High Deviation Alarm
Warns that the process is above setpoint, but below the high process variable. It can be used as either an alarm or control function.

High Power
(As defined by Watlow Anafaze) Any voltage above 24 Vac or Vdc and any current level above 50 mAac or mAdc.

High Process Alarm
A signal that is tied to a set maximum value that can be used as either an alarm or control function.

High Process Variable
See Process Variable (PV).

High Reading
An input level that corresponds to the high process value. For linear inputs, the high reading is a percentage of the full scale input range. For pulse inputs, the high reading is expressed in cycles per second (Hz).

I

Infrared (IR)
A region of the electromagnetic spectrum with wavelengths ranging from one to 1,000 microns. These wavelengths are most suited for radiant heating and infrared (noncontact) temperature sensing.

Input
Process variable information that is supplied to the instrument.

Input Scaling
The ability to scale input readings (readings in percent of full scale) to the engineering units of the process variable.

Input Type
The signal type that is connected to an input, such as thermocouple, RTD, linear or process.

Integral Control (I)
Control action that automatically eliminates offset, or droop, between setpoint and actual process temperature.

J

Job
A set of operating conditions for a process that can be stored and recalled in a controller's memory. also called a *recipe*.

Junction
The point where two dissimilar metal conductors join to form a thermocouple.

L

Lag
The delay between the output of a signal and the response of the instrument to which the signal is sent.

Linear Input
A process input that represents a straight line function.

Linearity
The deviation in response from an expected or theoretical straight line value for instruments and transducers. also called *linearity error*.

Liquid Crystal Display (LCD)
A type of digital display made of a material that changes reflectance or transmittance when an electrical field is applied to it.

Load
The electrical demand of a process, expressed in power (watts), current (amps) or resistance (ohms). The item or substance that is to be heated or cooled.

Loop Alarm
Any alarm system that includes high and low process, deviation band, deadband, digital outputs, and auxiliary control outputs.

Low Deviation Alarm
Warns that the process is below the setpoint, but above the low process variable. It can be used as either an alarm or control function.

Low Process Alarm
A signal that is tied to a set minimum value that can be used as either an alarm or control function.

Low Reading
An input level corresponding to the low process value. For linear inputs, the low reading is a percentage of the full scale input range. For pulse inputs, the low reading is expressed in cycles per second (Hz).

M

Manual Mode
A selectable mode that has no automatic control aspects. The operator sets output levels.

Manual Reset
See Reset.

Milliampere (mA)
One thousandth of an ampere.

MMI
Man-machine interface.

N

NO-Key Reset
A method for resetting the controller's memory (for instance, after an EPROM change).

Noise
Unwanted electrical signals that usually produce signal interference in sensors and sensor circuits. See also Electromagnetic Interference.

Noise Suppression
The use of components to reduce electrical interference that is caused by making or breaking electrical contact, or by inductors.

Nonlinear
Through Anafaze software, the Nonlinear field sets the system to linear control, or to one of two nonlinear control options. Input 0 for linear, 1 or 2 for nonlinear.

O

Offset
The difference in temperature between the setpoint and the actual process temperature. Offset is the error in the process variable that is typical of proportional-only control.

On/Off Control
A method of control that turns the output full on until setpoint is reached, and then off until the process error exceeds the hysteresis.

Open Loop
A control system with no sensory feedback.

Operator Menus
The menus accessible from the front panel of a controller. These menus allow operators to set or change various control actions or features.

Optical Isolation
Two electronic networks that are connected through an LED (Light Emitting Diode) and a photoelectric receiver. There is no electrical continuity between the two networks.

Output
Control signal action in response to the difference between setpoint and process variable.

Output Type
The form of PID control output, such as time

proportioning, distributed zero crossing, Serial DAC or analog. Also the description of the electrical hardware that makes up the output.

Overshoot
The amount by which a process variable exceeds the setpoint before it stabilizes.

P

Panel Lock
A feature that prevents operation of the front panel by unauthorized people.

PID
Proportional, Integral, Derivative. A control status with three functions: Proportional action dampens the system response, integral corrects for droops, and derivative prevents overshoot and undershoot.

Polarity
The electrical quality of having two opposite poles, one positive and one negative. Polarity determines the direction in which a current tends to flow.

Process Variable (PV)
The parameter that is controlled or measured. Typical examples are temperature, relative humidity, pressure, flow, fluid level, events, etc. The high process variable is the highest value of the process range, expressed in engineering units. The low process variable is the lowest value of the process range.

Proportional (P)
Output effort proportional to the error from setpoint. For example, if the proportional band is 20˚ and the process is 10˚ below the setpoint, the heat proportioned effort is 50%. The lower the PB value, the higher the gain.

Proportional Band (PB)
A range in which the proportioning function of the control is active. Expressed in units, degrees or percent of span. See also PID.

Proportional Control
A control using only the P (proportional) value of PID control.

Pulse Input
Digital pulse signals from devices, such as optical encoders.

R

Ramp
A programmed increase in the temperature of a setpoint system.

Range
The area between two limits in which a quantity or value is measured. It is usually described in terms of lower and upper limits.

Recipe
See Job.

Reflection Compensation Mode
A control feature that automatically corrects the reading from a sensor.

Relay
A switching device.

Electromechanical Relay — A power switching device that completes or interrupts a circuit by physically moving electrical contacts into contact with each other. Not recommended for PID control.

Solid State Relay (SSR) — A switching device with no moving parts that completes or interrupts a circuit electrically.

Reset
Control action that automatically eliminates offset or droop between setpoint and actual process temperature. See also Integral.

Automatic Reset — The integral function of a PI or PID temperature controller that adjusts the process temperature to the setpoint after the system stabilizes. The inverse of integral.

Resistance
Opposition to the flow of electric current, measured in ohms.

Resistance Temperature Detector (RTD)
A sensor that uses the resistance temperature characteristic to measure temperature. There are two basic types of RTDs: the wire RTD, which is usually made of platinum, and the thermistor which is made of a semiconductor material. The wire RTD is a positive temperature coefficient sensor only, while the thermistor can have either a negative or positive

temperature coefficient.

Reverse Action
An output control action in which an increase in the process variable causes a decrease in the output. Heating applications usually use reverse action.

RTD
See Resistance Temperature Detector.

S

Serial Communications
A method of transmitting information between devices by sending all bits serially over a single communication channel.

EIA/TIA-232—An Electronics Industries of America (EIA) standard for interface between data terminal equipment and data communications equipment for serial binary data interchange. This is usually for communications over a short distance (50 feet [15 m] or less) and to a single device.

EIA/TIA-485—An Electronics Industries of America (EIA) standard for electrical characteristics of generators and receivers for use in balanced digital multipoint systems. This is usually used to communicate with multiple devices over a common cable or where distances over 50 feet (15 m) are required.

Setpoint (SP)
The desired value programmed into a controller. For example, the temperature at which a system is to be maintained.

Shield
A metallic foil or braided wire layer surrounding conductors that is designed to prevent electrostatic or electromagnetic interference from external sources.

Signal
Any electrical transmittance that conveys information.

Solid State Relay (SSR)
See Relay, Solid State.

Span
The difference between the lower and upper limits of a range expressed in the same units as the range.

Spread
In heat/cool applications, the +/- difference between heat and cool. Also known as process deadband. See also Deadband.

Stability
The ability of a device to maintain a constant output with the application of a constant input.

T

T/C Extension Wire
A grade of wire used between the measuring junction and the reference junction of a thermocouple. Extension wire and thermocouple wire have similar properties, but extension wire is less costly.

TD (Timed Derivative)
The derivative function.

Thermistor
A temperature-sensing device made of semiconductor material that exhibits a large change in resistance for a small change in temperature. Thermistors usually have negative temperature coefficients, although they are also available with positive temperature coefficients.

Thermocouple (T/C)
A temperature sensing device made by joining two dissimilar metals. This junction produces an electrical voltage in proportion to the difference in temperature between the hot junction (sensing junction) and the lead wire connection to the instrument (cold junction).

TI (Timed Integral)
The Integral term.

Transmitter
A device that transmits temperature data from either a thermocouple or RTD by way of a two-wire loop. The loop has an external power supply. The transmitter acts as a variable resistor with respect to its input signal. Transmitters are desirable when long lead or extension wires produce unacceptable signal degradation.

U

Upscale Break Protection
A form of break detection for burned-out thermocouples. Signals the operator that the thermocouple has burned out.

Undershoot
The amount by which a process variable falls below the setpoint before it stabilizes.

V

Volt (V)
The unit of measure for electrical potential, voltage or electromotive force (EMF). See also Voltage.

Voltage (V)
The difference in electrical potential between two points in a circuit. It's the push or pressure behind current flow through a circuit. One volt (V) is the difference in potential required to move one coulomb of charge between two points in a circuit, consuming one joule of energy. In other words, one volt (V) is equal to one ampere of current (I) flowing through one ohm of resistance (R), or V = IR.

Z

Zero Cross
Action that provides output switching only at or near the zero-voltage crossing points of the ac sine wave.

Index

A

A control status symbol 56
AC LINE FREQ
  default value 74
  description 81
  location 73, 233
agency compliance
  controller 193
  power supply 205
  Serial DAC 210
ALARM ACK key
  acknowledging alarms 59–60
  description 54
  does not work 170
ALARM DEADBAND
  default value 99
  description 102
  location 73, 233
ALARM DELAY
  default value 99
  description 103
  location 73, 233
  location of 64
Alarm High SP parameter 67
Alarm Low SP parameter 67
alarms
  acknowledging 59–60
  alarm high, see process alarms
  alarm low, see process alarms
  codes 164, 166
  deadband 102
  delaying 64, 100, 103
  deviation 164
  deviation, see process alarms
  digital output polarity 81
  disabling control on alarm outputs 94
  displays 58
  failed sensor 65, 166
  global 99
  global alarm output 68
  high deviation alarm settings 100–101
  high process alarm settings 100
  hysteresis 68
  loop delay 64
  low deviation alarm settings 100–101
  low process alarm settings 102
  messages 166
  process 164
  resetting 165
  restoring control after sensor failure 92
  reversed thermocouple 85
  RTD, see failed sensor alarms
  SCRs 37
  sensor fail percent output power 97
  setting up 66–69
  setup parameters 99–103
  solid state relays 37
  startup delay 64, 78
  system 60, 166
  T/C BREAK, switching to manual mode 97
  thermocouple, see failed sensor alarms
  tolerance 138, 151
  troubleshooting 164, 166
  wiring 37
ambient temperature
  H/W AMBIENT FAILURE message 169
  operating range 12
AMBIENT WARNING 168
ANAINSTL 80
analog inputs, see sensor inputs
analog output 158
  see also Dual DAC or Serial DAC
ASSIGN R/S PROFILE 148
AUTO 56, 61
automatic control, selecting 61
automatic mode
  restoring after failed sensor repair 66
autotuning 62–64

B

BACK key 53
bar graph display 55–56
  control status symbols 56
  navigating in 56
  ramp/soak symbols 147
  symbols 55, 58
  when running ramp/soak profile 146
battery 7
BATTERY DEAD 166
baud rate 80
BCC, see block check character
block check character 80
boost output 67
bridge circuit 32

C

cables
  communications 9, 47
  SCSI 7, 9
  tie wrapping 35
  troubleshooting 175
CALCULATING CHECKSUM 28
CANNOT LOAD JOB 75
CANNOT SAVE JOB 75
CASCADE BASE SP
  description 120
  location 112, 233
CASCADE CL SPAN
  description 121
  location 112, 233
cascade control 118–124
  application example 121
  relationship of secondary setpoint to primary output 123
  setting up, example 122
  setup parameters 119–121
  testing setup, example 123
CASCADE HT SPAN
  description 121
  location 112, 233
CASCADE MAX SP
  description 120
  location 112, 233

CASCADE MIN SP
description 120
location 112, 233
CASCADE PRIM. LOOP
description 119
location 112, 233
case, removing 177
CE, see agency compliance
CHNG SP key
changing the setpoint 61
description 54
does not work 170
locking and unlocking 78
clearance, see installation
communications
baud rate 80
cable 9, 47
controller address 79
error checking algorithm 80
ground loops 24, 175
installation 45–49
jumper configurations 179
protocol 80
software problems 176
specifications 204
troubleshooting 174–176
wire sizes and lengths 22
see also EIA/TIA
COMMUNICATIONS BAUD RATE
default value 74
description 80
location 73, 233
COMMUNICATIONS ERR CHECK
default value 74
description 80
location 73, 233
COMMUNICATIONS PROTOCOL
default value 74
description 80
location 73, 233
computer, see communications 174
control algorithms 153–156
on/off 154
proportional (P) 154, 161
proportional with integral (PI) 155, 161
proportional, integral and derivative (PID) 155, 161
control outputs 157–162
action 96
automatic control, see automatic control
cascade control, see cascade control
control algoritms, see control algorithms
control status, see control status
curve 98
cycle time 95
direct action 96, 159
disabling 94
distributed zero crossing 94, 158
Dual DAC, see Dual DAC
enabling 94
filter 91, 158
limit 96
manual control, see manual control
on/off 94, 157
process variable retransmit 113
ratio control, see ratio control
reverse action 96, 159
SCRs 37
Serial DAC, see Serial DAC
solid state relays 37
spread 92
status on power up 78
time proportioning 94, 157
troubleshooting 172–173
wiring 37
control parameters 90–92
control status 61–64
symbols on display 56
unexpected switches from automatic to manual 167
controller
agency compliance 193
clearance 13, 195
connecting to TB50 27
dimensions 194
environment 194
input specifications 200–202
mounting 13–16
output specifications 202–204
specifications 193–196
terminal specifications 196
troubleshooting, see troubleshooting
wire sizes 196
CONTROLLER ADDRESS
default value 74
description 79
location 73, 233
COOL 56
COOL CONTROL FILTER
default value 90
description 91
location 73, 233
COOL CONTROL OUTPUT
default value 93
description 94
location 73, 233
COOL CONTROL PB
default value 90
description 91
location 73, 233
COOL CONTROL TD
default value 90
description 91
location 73, 233
COOL CONTROL TI
default value 90
description 91
location 73, 233
COOL OUTPUT
curves 98
description 98
location 73, 233
COOL OUTPUT ACTION
description 96
location 73, 233
COOL OUTPUT CYCLE TIME
description 95
location 73, 233

COOL OUTPUT LIMIT
description 96
location 73, 233
COOL OUTPUT LIMIT TIME
description 96
location 73, 233
COOL OUTPUT RETRANS PV
description 114
location 112, 233
COOL OUTPUT TYPE
description 94
location 73, 233
cool output, see control outputs
COOL RETRANS MAX INP
description 114
location 112, 233
COOL RETRANS MAX OUT%
description 115
location 112, 233
COOL RETRANS MIN INP
description 114
location 112, 233
COOL RETRANS MIN OUT%
description 114
location 112, 233
COOL T/C BRK OUT AVG
description 97
location 73, 233
COPY SETUP FROM PROFILE
description 138
location 136, 233
CPU watchdog timer 38, 203
CRC, see cyclic redundancy check
C-UL, see agency compliance
current inputs
scaling resistors 33, 181, 184
wiring 33
CYCLE NR= 147
cycle time 95
cyclic redundancy check 80

D

D/O alarm polarity parameter 68
DAC, see Dual DAC or Serial DAC
data logging 113, 115
derivative
description 155
guidelines for setting 160–162
setting a value 91
settings from other controllers 161
term versus rate settings 160
DEV ALARM VALUE
default value 99
description 100
location 73, 233
deviation alarms, see process alarms
differential control, see ratio control 131
DIG OUT POLARITY ON ALARM
default value 74
description 81
location 73, 233
DIGITAL INPUTS
default value 103
description 103
location 73, 233
using for testing 29
digital inputs
external switching devices 39
functions activated 39
output override 77
ramp/soak external reset 139
ramp/soak triggers 142
remote job selection 76–77
restoring control after sensor failure 92
specifications 202
technical information 38
testing 29, 103
thermocouple short detection 79
troubleshooting 173
wiring 38
DIGITAL OUTPUT NUMBER
default value 103
description 104
location 73, 233
digital outputs
polarity for alarms 81
ramp/soak events 141
specifications 203
testing 28, 104
troubleshooting 173
will not turn on 22
wiring 35–36
dimensions
controller 194
Dual DAC 20, 207
power supply 205–206
power supply bracket 19
Serial DAC 20, 209
TB50 196–199
direct action, see control outputs
DISP FORMAT
default value 82
description 87
effect on ramp/soak parameters 144
location 73, 233
scaling parameters 86
values 87
display
bar graph, see bar graph display
does not work 167
job display 60
process variable not correct 167, 171
single loop, see single loop display
distributed zero crossing 94, 158
down-arrow key 53
Dual DAC
configuring outputs 186–188
dimensions 20, 207
environment 207
input specifications 208
jumper settings 187
mounting 19–20
output specifications 208
process variable retransmit 113, 118
specifications 207–208
wiring 43–44
dust 12
DZC, see distributed zero crossing

E

earth, see ground
EDIT RAMP & SOAK PROFILE
  description 137
  location 136, 233
EDIT SEGMENT NUMBER
  description 140
  location 136, 233
EIA/TIA-232 45–46
  connections 46
  jumper configurations 179
  jumpers in connectors 46
  specifications 204
  troubleshooting 174–175
  see also communications
EIA/TIA-485 47–49
  EIA/TIA-232-to-485 converter 47, 49
  jumper configurations 179
  network connections 47–48
  signal common 48
  specifications 204
  termination 48
  troubleshooting 175
  see also communications
electrostatic discharge 177
EMI, see noise
encoders 34
enhanced features option 111–132
  cascade control, see cascade control
  firmware code shown on display 81
  menu tree 112
  process variable restransmit, see process variable retransmit
ENTER key 53
environment 12
  controller 194
  Dual DAC 207
  power supply 205
  Serial DAC 209
EPROM
  checksum 81
  replacing 176–178
error checking 80
ESD, see electrostatic discharge
external bridge circuit 32
EXTERNAL RESET INPUT NUMBER
  description 139
  location 136, 233
external safety devices 9
external switching devices 39
extruder control 107–110
extruder control algorithm 110
extruder firmware option code 81

F

failed sensor alarms
  restoring automatic control after sensor repair 66
  RTD open 66
  RTD shorted 66
  setting up 65–66
  thermocouple open 65
  thermocouple short 66
filter
  output 91, 158
  sensor input 89
firmware
  custom 82
  version 81
frequency 81
front panel 8
  navigation 51
  overview 52
FS alarm code 166
functions activated by digital inputs 39

G

gain, see proportional band
ground loops 24
  communications 47
  isolation 35
  paths 24
  and personal computers 24
  and thermocouples 31
  troubleshooting 172, 175
grounding, troubleshooting 172

H

H/W AMBIENT FAILURE 166, 169
H/W GAIN FAILURE 166, 170
H/W OFFSET FAILURE 166, 170
HD alarm code 164
HEAT 56
HEAT CONTROL FILTER
  default value 90
  description 91
  location 73, 233
HEAT CONTROL OUTPUT
  default value 93
  description 94
  location 73, 233
HEAT CONTROL PB
  default value 90
  description 91
  location 73, 233
HEAT CONTROL TD
  default value 90
  description 91
  location 73, 233
HEAT CONTROL TI
  default value 90
  description 91
  location 73, 233
HEAT OUTPUT
  curves 98
  default value 93
  description 98
  location 73, 233
HEAT OUTPUT ACTION
  default value 93
  description 96
  location 73, 233
HEAT OUTPUT CYCLE TIME
  default value 93
  description 95
  location 73, 233

HEAT OUTPUT LIMIT
default value 93
description 96
location 73, 233
HEAT OUTPUT LIMIT TIME
default value 93
description 96
location 73, 233
HEAT OUTPUT RETRANS PV
description 114
location 112, 233
HEAT OUTPUT TYPE
default value 93
description 94
location 73, 233
heat output, see control outputs
HEAT RETRANS MAX INP
description 114
location 112, 233
HEAT RETRANS MAX OUT%
description 115
location 112, 233
HEAT RETRANS MIN INP
description 114
location 112, 233
HEAT RETRANS MIN OUT%
description 114
location 112, 233
HEAT T/C BRK OUT AVG
default value 93
description 97
location 73, 233
HEAT/COOL SPREAD
location 233
Heat/Cool Thermocouple Break Out 65
HI DEV ALARM OUTPUT
default value 99
description 101
location 73, 233
HI DEV ALARM TYPE
default value 99
description 101
location 73, 233
HI PROC ALARM OUTPUT
default value 99
description 100
location 73, 233
HI PROC ALARM SETPT
default value 99
description 100
location 73, 233
HI PROC ALARM TYPE
default value 99
description 100
location 73, 233
high deviation alarm, see process alarms
HP alarm code 164
humidity
controller 194
Dual DAC 207
power supply 205
Serial DAC 209
hysteresis
alarm 68
hysteresis, see spread

I

INPUT FILTER
default value 82
description 89
location 73, 233
setting before autotuning 64
input power, see power supply
INPUT PULSE SAMPLE TIME
default value 82
description 85
location 73, 233
INPUT READING OFFSET
default value 82
description 84
location 73, 233
values 85
INPUT SCALING HI PV
default value 82
description 88
location 73, 233
scaling parameters 86
INPUT SCALING HI RDG
default value 82
description 88
location 73, 233
scaling parameters 86
INPUT SCALING LO PV
default value 82
description 88
location 73, 233
scaling parameters 86
INPUT SCALING LO RDG
default value 82
description 89
location 73, 233
scaling parameters 86
INPUT TYPE
default value 82
description 83
effect on ramp/soak parameters 144
location 73, 233
values 83
INPUT UNITS
default value 82
description 84
location 73, 233
inputs
analog, see sensor inputs
current, see current inputs
digital, see digital inputs
filter 89
pulse, see pulse inputs
RTD, see RTD
scaling resistors 180–186
sensor, see sensor inputs
setup parameters 82–89
specifications 200–202
thermocouple, see thermocouples
voltage, see voltage inputs
wiring, see installation
installation 11–49
alarm wiring 37
clearance 13–15, 195
communications 45–49

control output wiring 37
controller 13–16
CPU watchdog timer 38
digital output wiring 35–36
Dual DAC 19–20
environment 12
ground loops, see ground loops
location 12
noise suppression, see noise
overview 11
panel hole dimensions 15
panel thickness 15
power supply 18–19, 25–27
reference voltage terminals 32
sensor input wiring 29–34
Serial DAC 19–20
TB50 16–18, 27
testing 28–29
tie-wrapping cables 35
tools 13
torque for screw terminals 26
typical 12
wire recommendations 21, 30, 35, 47
wire sizes 22
wiring 21–27, 29–49
integral
description 155
guidelines for setting 160–162
setting a value 91
settings from other controllers 161
term versus reset settings 160

J

JOB RUNNING 60
JOB RUNNING DATA MODIFIED 60
JOB RUNNING REMOTELY LOADED 60
JOB SEL DIG INS ACTIVE
default value 74
description 77
location 73, 233
JOB SELECT DIG INPUTS
default value 74
description 76
location 73, 233
jobs
loading from memory 75
remote selection 76–77
saving to memory 75
jumpers
Dual DAC 187
EIA/TIA-232 179
EIA/TIA-485 179
in EIA/TIA-232 connectors 46
power supply common 27
Serial DAC 188
unused inputs 30
when using 2-wire RTD 32

K

KEYBOARD LOCK STATUS
default value 74
description 78
location 73, 233
keypad
ALARM ACK, see ALARM ACK key
BACK, see BACK key
CHNG SP, see CHNG SP key
ENTER, see ENTER key
keys do not work 167, 170
locking 78
MAN/AUTO, see MAN/AUTO key
NO, see NO key
overview 52
RAMP/SOAK, see RAMP/SOAK key
testing 105
unlocking 78
YES, see YES key
KEYPAD TEST
description 105
how to quit 105
location 73, 233

L

LD alarm code 164
limit controller 9
limit, output 96
linear inputs
decimal shift in ramp/soak parameters 145
display format 87
engineering units 84
scaling and calibration 186
scaling examples 189–192
scaling parameters 86–89
LO DEV ALARM OUTPUT
default value 99
description 101
location 73, 233
LO DEV ALARM TYPE
default value 99
description 101
location 73, 233
LO PROC ALARM OUTPUT
default value 99
description 102
location 73, 233
LO PROC ALARM SETPT
default value 99
description 102
location 73, 233
LO PROC ALARM TYPE
default value 99
description 102
location 73, 233
LOAD SETUP FROM JOB
CANNOT LOAD JOB 75
default value 74
description 75
job display 60
location 73, 233
locking the keypad 78
LOOP NAME
default value 82
description 84
location 73, 233
loops
autotuning, see autotuning
naming 84

number available 200
ramp/soak profiles, see ramp/soak 148
single loop display, see single loop display
tuning 159–161
low deviation alarm, see process alarms
LOW POWER 166, 168
LP alarm code 164

M

M control status symbol 56
MAN 56, 61
MAN/AUTO CONTROL OUTPUTS DISABLED 61
MAN/AUTO key 54
does not work 170
locking and unlocking 78
switching control statuses 61
manual control
selecting 61
setting the output level 62
MANUAL I/O TEST 103
location 73, 233
parameters in menu 103
menu tree
all setup menus 233
enhanced features 112
ramp/soak profiles 136
standard setup menus 73
menus
accessing 71
global parameters 74
loop alarms 99
loop control 90
loop input 82
loop outputs 93
manual I/O test 103
menu tree, see menu tree
process variable retransmit 113
ramp/soak profile 137
model information
accessing through display 81
location in firmware 73
model number description 5
mounting, see installation

N

NO key
description 53
NO-key reset 176
noise
eliminating problems with 23
isolation 23
reducing with zero-cross switching 158
suppression 22–23
symptoms 22

O

on/off control
control signal 157
description 154
selecting 94
spread 92
operator displays 51
OUT-OF-TOLRNCE ALARM TIME
description 138
location 136, 233
output override 77, 97
OUTPUT OVERRIDE DIG INPUT
default value 74
description 77
location 73, 233
outputs
5 Vdc output power 204
alarm, see alarms
analog, see Dual DAC or Serial DAC
boost output 67
control, see control outputs
CPU watchdog timer, see CPU watchdog timer
digital, see digital outputs
filter 91
process variable retransmit, see process variable retransmit
ramp/soak ready state 139
reference voltage, see reference voltage
setup parameters 93–98
solid state relays 37
specifications 202–204
wiring, see installation
OVERRIDE DIG IN ACTIVE
default value 74
description 77
location 73, 233
over-temperature shutdown devices 9

P

panel, see installation
parameters
accessing 71
alarm 99–103
changing values 72
control 90–92
global 74–82
input 82–89
menu tree, see menu tree
output 93–98
process variable retransmit 113
ramp/soak profile 137–143
storage of in RAM 7
test 103
parts list 5
personal computer, see communications 174
PID
autotuning, see autotuning
derivative constant, see derivative
integral term, see integral
proportional band, see proportional band
settings for various applications 162
settings from other controllers 161
tuning 159–161
PLC
transmitting process data to 113
using to set a setpoint, example 129
see also communications
power failure 10
output status upon restart 78
ramp/soak profile upon restart 152

power supply
dimensions 205–206
dimensions of mounting bracket 19
for Dual DAC 43
inputs 206
mounting 18–19
outputs 206
powering loads with 36
requirements 18
specifications 205–206
wiring 25–27
POWER UP OUTPUT STATUS
default value 74
description 78
effect on ramp/soak profiles 152
location 73, 233
process alarms
alarm high 67
alarm low 67
boost output 67
function 67
high deviation 68
low deviation 68
outputs 67
setting up 66
PROCESS POWER DIGIN
default value 74
description 79
location 73, 233
process variable
not displayed correctly 22, 167, 171
retransmit, see process variable retransmit
process variable retransmit 113–118
application example 115
scaling the output 115
setting up, example 116
setup parameters 113
profile, see ramp/soak
proportional band
and cascade control 123
description 154
guidelines for setting 159, 161–162
setting a value 91
settings for various temperature ranges 159
settings from other controllers 161
protocol 80
pulse inputs
display format 87
encoder signals 34
engineering units 84
loops available on 34
sample time 85
scaling and calibration 186
scaling parameters 86–89
specifications 201
technical information 34
wiring 34
PV, see process variable

R

RAM 7, 177
ramp/soak 133–152
assigning profiles to loops 148
continuing from hold 150
cycle number 147
decimal shift 145
editing a profile while it is running 149
events 141
firmware option code 81
holding a profile 150
mode symbols on display 146–147
mode, setting 147
overview 133–135
power failure while running profile 152
process variable retransmit, see process variable retransmit
profile setup parameters 137–143
resetting a profile 151
running a profile 148
screens for RAMP/SOAK key 145
specifications 135
time base 137
time remaining 147
tolerance 143
tolerance alarm, see alarms, tolerance
triggers 142
RAMP/SOAK key 54
assigning profiles 148
cycle number 147
does not work 64, 69, 170
locking and unlocking 78
screens accessed by pressing 145
set mode 147
time remaining 147
unassigning profiles 148
RAMP/SOAK TIME BASE
default value 74
description 137
location 73, 136, 233
ratio control 124–132
application example 126, 129, 131
differential control 131
remote analog setpoint 129
setting up, example 127, 129, 131
setup parameters 125–126
RATIO CONTROL CTRL RATIO
description 126
location 112, 233
RATIO CONTROL MAX SP
description 125
location 112, 233
RATIO CONTROL MIN SP
description 125
location 112, 233
RATIO CONTROL MSTR LOOP
description 125
location 112, 233
RATIO CONTROL SP DIFF
description 126
location 112, 233
READY EVENT OUTPUT
description 139
location 136, 233
READY SEGMENT EDIT EVENTS
description 139
location 136, 233
READY SEGMENT SETPOINT
description 138

location 136, 233
Ref terminals, see reference voltage
reference voltage 32, 204
remote analog setpoint, see ratio control
repair, returning controller for 164
REPEAT CYCLES
description 144
location 136, 233
reset
external 139
integral, see integral
NO-key reset 176
RESET PROFILE 148
RESET WITH DEFAULTS 176
RESTORE PID DIGIN
default value 90
description 92
location 73, 233
RestoreAuto parameter 66
retransmit, see process variable retransmit
returning the controller 164
reverse action, see control outputs
REVERSED T/C DETECT
default value 82
description 85
location 73, 233
RFI, see noise
RMA number 164
RO alarm code 166
RS alarm code 166
RS-232, see EIA/TIA-232
RS-485, see EIA/TIA-485
RT alarm code 166
RTD
accuracy 201
offset 84
range 201
recommended type 32
resolution 201
scaling resistors 32, 183
troubleshooting 171
wiring 32
RTD open alarm 66
RTD shorted alarm 66

S

safety
external safety devices 9
output status on power up 10
symbols and signal words in this manual 2
SAVE SETUP TO JOB
CANNOT SAVE JOB 75
default value 74
description 75
location 73, 233
scaling parameters
example settings, flow sensor with 0-5 Vdc signal 191
example settings, pressure sensor with 4-20mA signal 190
example settings, pulse encoder 192
linear inputs 86–89
process variable retransmit 114–115
pulse inputs 86–89
scaling resistors
CLS204 and CLS208 input circuit 180
CLS216 input circuit 184
for current inputs 33, 181, 184
for RTD inputs 32, 183
for thermistor inputs 183
for voltage inputs 32, 182, 185
installing 180–186
SCSI cable 7, 9
clearance 13–14, 195
installing 27
SDAC HI VALUE
default value 93
description 95
location 233
SDAC LO VALUE
default value 93
description 95
location 233
SDAC MODE
default value 93
description 95
location 233
SEG ## EV# DO## ACTIVE STATE
description 141
location 136, 233
SEG ## EVENT # OUTPUT
description 141
location 136, 233
SEG ## TR# DI## ACTIVE STATE
description 142
location 136, 233
SEG ## TR# DI## TRIG
description 143
location 136, 233
SEG ## TRIG # INPUT NR
description 142
location 136, 233
SEGMENT ## EDIT SEG EVENTS
description 141
location 136, 233
SEGMENT ## EDIT SEG TRGGRS
description 142
location 136, 233
SEGMENT ## LAST SEGMENT
description 144
location 136, 233
SEGMENT ## SEG SETPT
description 140
location 136, 233
SEGMENT ## SEG TIME
description 140
location 136, 233
SEGMENT ## SEG TOLERANCE
description 143
location 136, 233
SENSOR FAIL CL OUTPUT
and output override feature 77
and reversed thermocouple detection 85
and thermocouple short detection 79
description 97
location 73, 233
values 97
Sensor Fail Cool Output parameter
and failed sensor alarm 65

Sensor Fail Heat Output parameter
and failed sensor alarm 65
SENSOR FAIL HT OUTPUT
and output override feature 77
and reversed thermocouple detection 85
and thermocouple short detection 79
default value 93
description 97
location 73, 233
values 97
sensor inputs
engineering units 84
failed sensor alarms 166
filter 89
offset 84
ranges 83
specifications 200
troubleshooting 171
type, setting 83
wiring 29–34
Serial DAC
agency compliance 210
clock input 210
configuring outputs 188
configuring the controller output 94
dimensions 20, 209
environment 209
input specifications 210
jumper positions 188
mounting 19–20
output specifications 211
process variable retransmit 113, 118
specifications 209–211
wiring 44–45
SET COOL OUTPUT 62
SET HEAT OUTPUT 62
SET MODE 147–148
SETPOINT 61
setpoint
changing 61
ramp/soak ready setpoint 138
using cascade control to set 118
using PLC to set, example 129
using ratio control to set 124
SETUP GLOBAL PARAMETERS 74
location 73, 233
parameters in menu 74
SETUP LOOP ALARMS 99
location 73, 233
parameters in menu 99
SETUP LOOP CASCADE 119
location 112, 233
SETUP LOOP CONTROL PARAMS 90
location 73, 233
parameters in menu 90
SETUP LOOP INPUT 82
location 73, 233
parameters in menu 82
SETUP LOOP OUTPUTS 93
location 73, 233
parameters in menu 93
SETUP LOOP PV RETRANSMIT
description 113
location 112, 233
SETUP LOOP RATIO CONTROL
description 125
location 112, 233
SETUP RAMP/SOAK PROFILE 137
location 136, 233
shutdown devices 9
single loop display 56
control status symbols 56
navigating 57
ramp/soak symbols 146
when running ramp/soak profile 146
solid state relays
5 Vdc power from controller 204
distributed zero crossing 158
troubleshooting controller connections 173
specifications 193–211
communications 204
controller 204
controller inputs 200–202
controller outputs 202–204
CPU watchdog timer 203
Dual DAC 207–208
power supply 205–206
Serial DAC 209–211
TB50 196
SPREAD
default value 90
description 92, 156
location 73
spread 92
ST alarm code 166
STARTUP ALARM DELAY
default value 74
description 78
location 73, 233

T

T control status symbol 56
TB18
alarm outputs 37–38
connections 40
CPU watchdog timer output 38
digital output wiring 36
testing after installation 28
to power encoders 34
troubleshooting 173
TB50
alarm outputs 37–38
connecting to controller 27
connections for CLS204 41
connections for CLS208 41
connections for CLS216 42
CPU watchdog timer output 38
digital output wiring 36
dimensions 196–199
for powering Serial DAC 44
mounting on DIN rail 17
mounting with standoffs 18
specifications 196
technical description 8
terminal specifications 197
testing after installation 28
to power encoders 34
troubleshooting 173

TD, see derivative
temperature
  incorrect on display 167, 171
  operating 194, 205, 207, 209
  storage 194, 205, 207, 209
terminal specifications
  controller 196
  TB50 197
TEST DIGITAL OUTPUT
  default value 103
  description 104
  location 73, 233
testing
  TB18 after installation 28
  TB50 after installation 28
  see also troubleshooting
thermistor inputs, scaling resistors for 183
Thermocouple Short Alarm parameter 66
thermocouples
  accuracy 201
  ground loops 31
  manual mode if break occurs 97
  offset 84
  polarity checking 85
  range 201
  resolution 201
  reversed detection 85
  short detection 79
  troubleshooting 171
  types supported 83
  wiring 31–32
thermoforming example 131
three-key sequence 71
TI, see integral
tie wraps 35
TIM REM= 147
time proportioning 94
  cycle time 95
  description 157
TOHO 151
torque, see terminal specifications
triggers, ramp/soak 142
troubleshooting 163–176
  alarms 164, 166
  all loops are set to manual 0% 167
  AMBIENT WARNING 168
  check these things first 163
  communications 174–176
  control outputs 172–173
  control status switches unexpectedly 167
  digital inputs 29, 103, 173
  digital outputs 28, 104, 173
  display does not work 167
  grounding problems 172, 175
  H/W AMBIENT FAILURE 169
  H/W GAIN FAILURE 170
  H/W OFFSET FAILURE 170
  keypad 105, 167, 170
  LOW POWER 168
  process variable incorrect on display 167, 171
  sensor inputs 171
  software 176
  TB18 173
  TB50 173
  tolerance alarms 151
  unexpected behavior 167
TUNE 56, 61, 64
tuning control loops 159–161

U

UL, see agency compliance
under-temperature shutdown devices 9
unlocking the keypad 78
up-arrow key 53

V

voltage inputs
  ranges 202
  resistance 202
  scaling resistors 32, 182, 185
  wiring 32

W

weight
  controller 194
  Dual DAC 207
  power supply 205
  Serial DAC 209
  TB50 196
wire sizes
  controller 196
wiring, see installation

Y

YES key 53

Menu Structure

SETUP GLOBAL PARAMETERS (p. 74)	SETUP LOOP INPUT (p. 82)	SETUP LOOP CONTROL PARAMS (p. 90)	SETUP LOOP OUTPUTS (p. 93)	SETUP LOOP ALARMS (p. 99)	MANUAL I/O TEST (p. 103)
LOAD SETUP FROM JOB	INPUT TYPE	HEAT CONTROL PB	HEAT CONTROL OUTPUT	HI PROC ALARM SETPT	DIGITAL INPUTS
SAVE SETUP TO JOB	LOOP NAME	HEAT CONTROL TI	HEAT OUTPUT TYPE	HI PROC ALARM TYPE	TEST DIGITAL OUTPUT
JOB SELECT DIG INPUTS	INPUT UNITS	HEAT CONTROL TD	HEAT OUTPUT CYCLE TIME	HI PROC ALARM OUTPUT	DIGITAL OUTPUT NUMBER XX
JOB SEL DIG INS ACTIVE	INPUT READING OFFSET	HEAT CONTROL FILTER	SDAC MODE	DEV ALARM VALUE	KEYPAD TEST
OUTPUT OVERRIDE DIG INPUT	REVERSED T/C DETECT	COOL CONTROL PB	SDAC LO VALUE	HI DEV ALARM TYPE	TEST DISPLAY
OVERRIDE DIG IN ACTIVE	INPUT PULSE SAMPLE TIME	COOL CONTROL TI	SDAC HI VALUE	HI DEV ALARM OUTPUT	
STARTUP ALARM DELAY	DISP FORMAT	COOL CONTROL TD	HEAT OUTPUT ACTION	LO DEV ALARM TYPE	
RAMP/SOAK TIME BASE	INPUT SCALING HI PV	COOL CONTROL FILTER	HEAT OUTPUT LIMIT	LO DEV ALARM OUTPUT	
KEYBOARD LOCK STATUS	INPUT SCALING HI RDG	SPREAD	HEAT OUTPUT LIMIT TIME	LO PROC ALARM SETPT	
POWER UP OUTPUT STATUS	INPUT SCALING LO PV	RESTORE PID DIGIN	SENSOR FAIL HT OUTPUT	LO PROC ALARM TYPE	
PROCESS POWER DIGIN	INPUT SCALING LO RDG		HEAT T/C BRK OUT AVG	LO PROC ALARM OUTPUT	
CONTROLLER ADDRESS	INPUT FILTER		HEAT OUTPUT	ALARM DEADBAND	
COMMUNICATIONS BAUD RATE			COOL CONTROL OUTPUT	ALARM DELAY	
COMMUNICATIONS PROTOCOL			COOL OUTPUT TYPE		
COMMUNICATIONS ERR CHECK			COOL OUTPUT CYCLE TIME		
AC LINE FREQ			SDAC PARAMETERS		
DIG OUT POLARITY ON ALARM			COOL OUTPUT ACTION		
CLS200 [FIRMWARE INFO.]			COOL OUTPUT LIMIT		
			COOL OUTPUT LIMIT TIME		
			SENSOR FAIL CL OUTPUT		
			COOL T/C BRK OUT AVG		
			COOL OUTPUT		

Additional Enhanced Features Option Menus

SETUP LOOP PV RETRANSMIT	SETUP LOOP CASCADE (p. 119)	SETUP LOOP RATIO CONTROL (p. 125)
HEAT OUTPUT RETRANS PV	CASCADE PRIM. LOOP	RATIO CONTROL MSTR LOOP
HEAT RETRANS MIN INP	CASCADE BASE SP	RATIO CONTROL MIN SP
HEAT RETRANS MIN OUT%	CASCADE MIN SP	RATIO CONTROL MAX SP
HEAT RETRANS MAX INP	CASCADE MAX SP	RATIO CONTROL CTRL RATIO
HEAT RETRANS MAX OUT%	CASCADE HT SPAN	RATIO CONTROL SP DIFF
COOL OUTPUT RETRANS PV	CASCADE CL SPAN	
COOL RETRANS MIN INP		
COOL RETRANS MIN OUT%		
COOL RETRANS MAX INP		
COOL RETRANS MAX OUT%		

Additional Ramp/Soak Option Menus

SETUP LOOP PV RETRANSMIT	SETUP RAMP/SOAK PROFILE (p. 137)
HEAT OUTPUT RETRANS PV	EDIT RAMP & SOAK PROFILE
HEAT RETRANS MIN INP	COPY SETUP FROM PROFILE
HEAT RETRANS MIN OUT%	OUT-OF-TOLRNCE ALARM TIME
HEAT RETRANS MAX INP	READY SEGMENT SETPOINT
HEAT RETRANS MAX OUT%	READY SEGMENT EDIT EVENTS
COOL OUTPUT RETRANS PV	READY EVENT OUTPUT
COOL RETRANS MIN INP	EXTERNAL RESET INPUT NUMBER
COOL RETRANS MIN OUT%	EDIT SEGMENT NUMBER
COOL RETRANS MAX INP	SEGMENT ## SEG TIME
COOL RETRANS MAX OUT%	SEGMENT ## SEG SETPT
	SEGMENT ## EDIT SEG EVENTS
	SEG ## EVENT # OUTPUT
	SEG ## EV# DO## ACTIVE STATE
	SEGMENT ## EDIT SEG TRGGRS
	SEG ## TRIG # INPUT NR
	SEG ## TR# DI## ACTIVE STATE
	SEG ## TR# DI## TRIG
	SEGMENT ## SEG TOLERANCE
	SEGMENT ## LAST SEGMENT
	REPEAT CYCLES

Declaration of Conformity

Declaration of Conformity

CLS200 Series CE

WATLOW ANAFAZE
314 Westridge Drive
Watsonville, California 95076 USA

English

Declares that the following product:

Designation:	CLS200 Series
Model Number(s):	2 (04, 08 or 16) - (1,2,3 or 4) (0,1 or 2) (0 or 2) (0,1,2 or 3) (0,1,2 or 3) (0,1, or 2) (1 or 2 letters or numbers)
Classification:	Installation Category II, Pollution Degree II
Rated Voltage:	15 to 24 VDC
Rated Current:	610mA maximum

Meets the essential requirements of the following European Union Directive(s) using the relevant section(s) of the normalized standards and related documents shown:

89/336/EEC Electromagnetic Compatibility Directive

EN 61326:	**1997**	**Electrical equipment for measurement, control and laboratory use - EMC requirements (Class A)**
EN 61000-3-2:	1995	Limits for harmonic current
EN 61000-3-3:	1995	Limitations of voltage fluctuations and flicker
EN 61000-4-2:	1995	Electrostatic discharge
EN 61000-4-3:	1997	Radiated immunity
EN 61000-4-4:	1995	Electrical fast transients
EN 61000-4-5:	1995	Surge immunity
EN 61000-4-6:	1994	Conducted immunity
EN 61000-4-11:	1994	Voltage dips, short interruptions and voltage variations immunity
ENV 50204:	1995	Cellular phone

Français

Déclare que le produit suivant :

Désignation :	Série CLS200
Numéro(s) de modèle(s):	2 - (04, 08 ou 16) - (1, 2, 3 ou 4) (0,1 ou 2) (0, 1 ou 2) (0, 1, 2 ou 3) (0, 1, 2 ou 3) (0, 1 ou 2) (1 ou 2 lettres ou chiffren)
Classification :	Installation catégorie II, degré de pollution II
Tension nominale :	15 à 24V c.c.
Courant nominal :	610 mA maximum

Conforme aux exigences de la (ou des) directive(s) suivante(s) de l'Union Européenne figurant aux sections correspondantes des normes et documents associés ci-dessous :

89/336/EEC Directive de compatibilité électromagnétique

EN 61326:	**1995**	**Appareillage électrique pour la mesure, la commande et l'usage de laboratoire —– Prescriptions relatives à la Compatilité Electro Magnétique (Classe A)**
EN 61000-3-2 :	1995	Limites d'émission de courant harmon ique
EN 61000-3-3 :	1995	Limites de fluctuation de tension
EN 61000-4-2 :	1995	Décharge électrostatique
EN 61000-4-3:	1997	Insensibilité à l'énergie rayonnée
EN 61000-4-4 :	1995	Courants électriques transitoires rapides
EN 61000-4-5 :	1995	Insensibi lité aux surtensions
EN 61000-4-6:	1996	Insensibilité à l'énergie par conduction
EN 61000-4-11 :	1994	Insensibilité aux chutes subites, aux courtes interruptions et aux variations de tension
ENV 50204 :	1995	Téléphone cellulaire

Deutsch

Erklärt, daß das folgende Produkt:

Beschreibung:	Serie CLS200
Modellnummer(n):	2 (04, 08 oder 16) - (1, 2, 3 oder 4) (0,1 oder 2) (0,1 oder 2) (0,1,2 oder 3) (0,1,2 oder 3) (0,1 oder 2) (1 oder 2 Buchstabe oder Ziffern)
Klassifikation:	Installationskategorie II, Emissionsgrad II
Nennspannung:	15 bis 24 Vdc
Nominaler Stromverbrauch:	max. 610 mA

Erfüllt die wichtigsten Normen der folgenden Anweisung(en) der Europäischen Union unter Verwendung des wichtigsten Abschnitts bzw. der wichtigsten Abschnitte der normalisierten Spezifikationen und der untenstehenden einschlägigen Dokumente:

89/336/EEC Elektromagnetische Übereinstimmungsanw é

EN 61326:	**1997**	**Elektrogeräte zur Messung, Regelung und zum Laboreinsatz EMC - Richtlinien (Klasse A)**
EN 61000-3-2:	1995	Grenzen der Oberwellenstromemissionen
EN 61000-3-3:	1995	Grenzen der Spannungsschwankungen
EN 61000-4-2:	1995	Elektrostatische Entladung
EN 61000-4-3:	1997	Strahlungsimmunität
EN 61000-4-4:	1995	Elektrische schnelle Stöße
EN 61000-4-5:	1995	Spannungsstoßimmunität
EN 61000-4-6:	1994	Störimmunität
EN 61000-4-11:	1994	Immunität gegen Spannungsgefälle, kurze Unterbrechungen und Spannungsabweichungen
ENV 50204:	1995	Mobiltelefon

Español

Declara que el producto siguiente:

Designación:	Serie CLS200
Números de modelo:	2 - (04, 08 ó 16) - (1, 2, 3 ó 4) (0,1 ó 2) (0,1 ó 2) (0,1,2 ó 3) (0,1,2 ó 3) (0,1 ó 2) (1 ó 2 letras ó numeros)
Clasificación:	Categoría de instalación II, grado de contaminación ambiental II
Tensión nominal:	15 a 24Vcc
Consumo nominal de energía:	610 mA máximo

Cumple con los requisitos esenciales de las siguientes Directivas de la Unión Europea, usando las secciones pertinentes de las reglas normalizadas y los documentos relacionados que se muestran:

89/336/EEC - Directiva de Compatibilidad Electromagn é

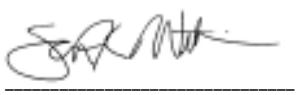
EN 61326:	**1997**	**Equipo elétrico para medición control y uso en laboratorios - Requisitos de compatibilidad electromagnética (Clase A)**
EN 61000-3-2	1995	Límites para emisiones de corriente armónica
EN 61000-3-3	1995	Limitaciones de fluctuaciones del voltaje
EN 61000-4-2:	1995	Descarga electrostática
EN 61000-4-3:	1997	Inmunidad radiada
EN 61000-4-4:	1995	Perturbaciones transitorias eléctricas rápidas
EN 61000-4-5:	1995	Sobretensión
EN 61000-4-6:	1994	Inmunidad conducida
EN 61000-4-11:	1994	Caídas de tensión, interrupciones breves y variaciones de tensión
ENV 50204:	1995	Teléfono portátil

Sean Wilkinson
Name of Authorized Representative

Watsonville, California. USA
Place of Issue

Manager
Title of Authorized Representative

Feb 28, 2003
Date of Issue



Signature of Authorized Representative